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TP 4334E

CANADIAN AIRSPACE SYSTEMS PLAN

FACILITIES, EQUIPMENT AND ASSOCIATED DEVELOPMENT

Canada

APRIL 1986

Transport Canada Transports Canada

Aviation Aviation

Your file Votre référence

Our File Notre référence

MAR 2 1987

Dear Sir/Madam:

Subject: Canadian Airspace Systems Plan - 1986 Edition

Please find attached a copy (copies) of the 1986 edition of the Canadian Airspace Systems Plan.

This issue supersedes the 1983 Plan and responds to updated user requirements, reports progress in implementation, and indicates areas in which engineering development will be carried out.

Any comments you may wish to forward to assist us in preparing the 1988 edition would be welcome.

Yours truly,

Barry D. Blair
Director General
Air Navigation

Attach.

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FOREWORD

The role of the Canadian Air Navigation System is to provide for the safe and efficient operation of aircraft within Canadian managed airspace. This role is met through formulation of rules and procedures governing the operation of aircraft within the airspace and on airports, and the provision of a variety of services including aeronautical information, aviation weather, flight planning, air traffic control, flight advisory, and enroute and approach navigation aids.

Many complex systems are used in support of the provision of these services. Over past years these systems have not kept up-to-date with user requirements and capabilities, nor with the need to provide services safely and efficiently. The growing shortfall between needs and abilities in handling North American air traffic was recognized by both Canada and the United States in the late 1970's. Steps have been taken by both countries in close collaboration with each other and with other International Civil Aviation Organization member states to develop plans for the modernization of their air navigation systems.

Given the large amount of national and international traffic which operates north/south in North America, it is essential that approaches to modernization of the Canadian and U.S. Air Navigation Systems be closely coordinated to ensure that the border remains transparent to users of North American airspace. This has been accomplished through each country publishing an "Airspace Systems Plan" on a periodic basis with the respective documents being organized in a way which facilitates comparison and coordination. Also, both countries have organized "Airspace Reviews" with joint participation in which all aspects, including rules and procedures, of the respective Air Navigation Systems are thoroughly assessed in consultation with user organizations.

Canada published its first Canadian Airspace Systems Plan in October 1983. This second issue responds to updated user requirements, reports progress in systems engineering design and management and indicates areas in which research will be carried out for planning beyond the year 2,000.

While called a "Plan", the contents of this document range from recording decisions that have been taken concerning modernization of certain components of the Canadian Air Navigation System, for example the Radar Modernization Project, through projects that are well advanced in the approval process such as the Flight Data Modernization Project. Finally, the document provides forecasts as to when certain advanced technology, such as satellites and automatic weather machines, can be considered as potential solutions to user and provider needs that are being formulated in the Canadian Airspace Review, and other processes.

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Issuance every two years of an updated edition of the document is intended to serve a number of purposes. These include:

- Communicating proposals to users of the Air Navigation System thereby providing an opportunity for advance planning and for consultation.

- Informing the Canadian electronics industry of possible future Air Navigation System requirements.

- Establishing an agreed-upon schedule for integration of the various systems for use by operators of the systems (e.g. Air Traffic Services Branch) and by the providers of the systems (Facility Engineering and Systems Development Branch).

- Communicating to all Air Navigation System managers and staff information relating to systems replacement and restoration.

- Coordinating systems changes with other International Civil Aviation Organization member nations operating air navigation systems, especially the United States.

It is with these purposes in mind that this second edition of the Canadian Airspace Systems Plan is issued. Comments will be very welcome and will assist in the preparation of the third issue which will be published in 1988.

Barry D. Blair
Director General
Air Navigation

CANADIAN AIRSPACE SYSTEMS PLAN 1986 EDITION

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CHAPTER 1

EXECUTIVE SUMMARY AND OVERVIEW

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ILLUSTRATIONS

1.1 THE PRESENT SYSTEMS

Today's systems providing airspace services are a combination of equipment, techniques, procedures and skills that have evolved over many years. This evolution has produced a mix of equipment of many technologies and types. The total system is safe and effective, but it is very expensive to operate and maintain. It has limited expansion capability and is difficult to adapt to changing requirements.

Today's systems are characterized by:

- high operation and maintenance costs where vacuum tube type electronic equipment is in use;

- multiplicity of leased communication lines;

- limited capacity and capability of equipment used in the air traffic control system;

- different types of computers and software languages in each ATC sub-system;

- different types of controller consoles and display equipment in enroute and terminal facilities;

- inefficient air traffic data transfer;

- highly labour-intensive operations involving extensive supply, training and technical support resulting in low productivity and capacity in the air traffic services;

- almost exclusive reliance on tactical air traffic control methods;

- inflexible route structure design;

- no systems integration and no interfacility data acquisition and transfer;

- diminishing runway capacity at some major airports and a limited capacity to predict air traffic congestion and the subsequent need for flow management;

- inability to meet the demand for pre-flight aviation weather briefings;

- limited access to real-time weather data.

The system must be modernized to overcome its deficiencies and to meet the demand for improved services. Adding more technicians, controllers, or expanding the current system in other ways will only compound its difficulties. Also, this approach is wasteful, because it requires considerable capital investment and simply postpones an effective solution.

1.2 OBJECTIVES OF THE PLAN

The central purpose of the restoration and replacement program outlined in the plan is to establish an optimized technical framework of systems which will improve the safety, capacity, productivity and economy of the Air Navigation System. Specific objectives include:

- having an operating national airspace system set-up in time to meet demand;

- accommodating the demand with minimal artificial constraints and with increasing fuel efficiency;

- reducing risks of mid-air and surface traffic collision, landing and weather-related accidents and collisions with the ground;

- reducing air traffic congestion at major airports at peak demand times;

- increasing the productivity of air traffic controllers and flight service specialists;

- minimizing the technical staff required to maintain and operate the modernized, expanded system;

- maximizing the return on the capital investment through a reduction in operating and maintenance costs of air traffic services.

This plan reflects the best technical judgement about what is required to meet these objectives. The plan is flexible enough to:

- adjust to future demands and technology;
- improve safety services;
- increase productivity;
- constrain costs;
- permit a national system evolution;
- minimize restriction to users.

1.3 ASSUMPTIONS

The Systems Plan is based on the following assumptions:

- in the process of modernization, system changes will be necessary to accommodate foreseeable air traffic growth and changing demands for services;

- the right of access to Canadian airspace by any class of user should not be constrained unnecessarily;

1.3 ASSUMPTIONS Cont'd

- in order to operate in designated airspace, specific avionics equipment might be required in the interest of all users of that airspace;

- individual user's preferences for routes, runways, approaches, altitudes, etc., will be honoured unless they cause delays to other users;

- no change to the system will be permitted which reduces safety or increases risk. A very high level of mid-air collision avoidance assurance will be afforded by the ground-based system. Back-up, ground-independent, airborne separation devices provided by the user, will be accommodated;

- no new major air-carrier airports are planned within the time frame of system implementation. Where physical expansion is limited, additional capacity will be achieved primarily through a reduction in separation minima resulting from technological advances, refinements in ATC procedures and through runway, terminal and access improvements;

- fuel costs will continue to be a major portion of airline operating costs.

- user-pay philosophy will receive increased emphasis.

1.4 ASPECTS OF THE PLAN

The Canadian Airspace Systems Plan contains a development and integration strategy for modernizing and improving the systems of facilities and equipment utilized in the provision of service within the Air Navigation System, up until the year 2000.

It addresses the issue of how best to restore and replace aging and obsolete equipment using the optimum technical solutions, accommodating operational demands for service while constraining costs.

The plan delineates specific improvements to facilities and equipment and supports engineering development associated with the systems needed for providing the various services to air traffic in airspace of Canadian jurisdiction. Particular emphasis is focused on air traffic control, flight services, aviation weather, ground to air (communications, navigation and surveillance), interfacility communication networks and maintenance and operations support systems.

The volume of air traffic requiring use of these systems varies geographically. Consequently, this plan recognizes and caters to a high density traffic area in the southern part of Canada and a low density traffic area in the north.

1.4 ASPECTS OF THE PLAN Cont'd

Demand for service has been assumed to increase at a moderate rate during the planning period, as derived from the Aviation Group's general forecast for aviation growth.

The scope and capability of the Systems Plan in terms of the technical framework of facilities and equipment required, complements the framework of groundside systems at Canadian airports to provide the basis for a balanced, efficient national air transportation system.

The theme throughout the Plan is that safety, capacity, productivity and economy will be chiefly realized through greater automation, consolidation of certain facilities and services and the application of the latest technologies to reduce systems operating costs.

The improvements offered in the Systems Plan provide a wide range of benefits to all users of Canadian Airspace. Flight-information and alerting services will be considerably enhanced. The process for filing flight plans will be simplified and there will be improved dissemination of flight data, the automation of which will benefit all users. Pilots will have easy access to the weather information specifically needed. For those aircraft carrying sophisticated equipment, the future controlled environment will be much less restrictive due to greater automation; this will permit users to choose the most efficient profile and receive optimum clearances.

The plan will accommodate a wide range of navigation capabilities, permitting all users to maximize their own potential in the system.

Air Traffic Control personnel will become more like system managers, with reliable automation carrying out the detailed data processing needed to determine clearances. Flight safety and expedition will be enhanced.

The plan also describes approved projects already underway. These will continue as planned but will blend in with the new projects, to ensure that an integrated system of facilities and equipment will evolve in time to respond to the needs and demands of Canadian aviation and the future users of Canadian airspace.

1.5 THE STRUCTURE OF THE PLAN

Following this overview, Chapter 2 provides a review of the demands on the system. Chapters 3 to 8 contain narrative descriptions of the components of the systems and their evolution through current progress (to 1985), the near term (to 1990), and long term (to 2000). The evolution is also shown in diagrams which indicate the relationships among programs and systems. Chapter 9 describes the engineering development program required to facilitate the implementation of the Canadian Airspace Systems Plan.

The descriptions in Chapters 3 to 8 are further illustrated by a series of maps depicting changes in equipment locations during the life of the plan. This is followed by a short discussion, indicating the benefits of the plan. The remaining portion of each chapter provides a description of the major Facilities and Equipment programs leading to the acquisition of systems, equipment or software. Projects within each program provide the purpose of the project, the approach to be taken to meet a specific need, the quantities being acquired, and a listing of related projects. Following these are two charts depicting the schedules or major milestones to be met, both for the Facilities and Equipment and for the Engineering Development portions of the project.

It should be noted that, although specific locations could be assumed for facilities marked on the maps in the technical chapters and specific time frames are provided for project development on the evolution charts and project sheets, these are representative of likely locations and likely dates as perceived in the current strategy. Project approval, specific locations and planning dates will be determined when each program is put forward in the normal departmental programming process. Therefore, the Canadian Airspace Systems Plan represents the strategy for implementation of the future systems needed. The strategy can change, arising from future needs, with constant surveillance of projects being made to ensure that the requirements for integration are satisfied.

1.6 HIGHLIGHTS OF THE PLAN

1.6.1 AIR TRAFFIC SERVICES SYSTEM

Canada's Air Traffic Services organization is responsible for providing air traffic control (ATC) and advisory services in national and international (oceanic) airspace. ATC Services are provided from Area Control Centres (ACCs), Terminal Control Units (TCUs) and Towers (TWRs). With regard to meeting ATC requirements the plan emphasizes the following systems and equipment aspects:

- Extended use of automation in conflict prediction and resolution to permit increased control capacity and efficiency.

- The use of common controller workstations with common modular hardware, and software based on the use of a high level language.

- Air-ground data-link for automatic two-way transfer of information (clearances, weather, etc.).

Emphasis on these aspects is aimed at maintaining a high level of safety, imposing a minimum of constraint on users, improving controller productivity, improving fuel efficiency, and reducing operating costs.

The systems and equipment used in ATC facilities will be standardized, with most hardware and software elements being identical. The computer systems and controller workstations for the ACCs and TCUs will be the same except for the capacity of the computers. Appropriate communications control systems to support the ATC operation will be provided. To the extent practicable, TWR's will use the same equipment.

A distributed processing approach to data management will continue to be the basis of the ATC System design. Central processors, such as the Flight Data Processing System and the Aeronautical Information Processing System, will support large data bases accessible by all ATS facilities and carry out major processing functions.

The workstations will provide a new environment in which air traffic controllers will be able to function more efficiently and effectively. Each station will contain some redundant micro-processors and the digital displays will be functionally inter-changeable. Tactical data (plan view traffic situation), will be displayed, as well as supplementary aviation information. Additionally, strategic displays will replace the current flight strips for indication of flight plan data. Planning/probing displays will be used for indication of conflict-free, fuel-efficient flight profiles.

1.6.1 AIR TRAFFIC SERVICES SYSTEM Cont'd

The workstation processors will be designed to enable a degree of autonomous operation and will select required surveillance, flight data and weather information from distribution networks and process data necessary for the particular controller position. If a central processor fails, the workstation processors will be able to provide essential service by utilizing information available on distribution networks, combined with that maintained in local data bases.

The distributed processing and network techniques inherently provide high availability and protection from total system failure. This enables increased operational flexibility since the number of ACC controller operating positions can be reconfigured to meet changing demand based on day-to-day or hour-to-hour workload considerations. With daily variations in traffic demand Controller workstations and associated communications can be configured into appropriately-sized operating sectors with optimum staffing.

System standardization techniques will establish a series of automation, display and communications systems that provide a wide range of benefits and cost reductions. Common systems require lower investment in development and procurement. Additionally, due to the commonality of operations and maintenance, engineering and staff support, logistics and training support, their life-cycle costs are reduced.

1.6.2 FLIGHT SERVICE SYSTEM

The flight service system encompasses all those services and facilities which provide information and advice to assist the pilot in the planning and conduct of his flight. The provision of such information is a primary responsibility of the Flight Service Station (FSS).

This chapter of the Plan details the following major areas of development in flight service systems.

- The application of automation techniques, such as automated weather observing systems, direct user access terminals and remote communications outlets will permit consolidation of facilities to a nucleus of Hub Stations, serving a number of remote stations by the year 2000 and a reduction in overall operating costs.

- Taking advantage of state-of-the-art technology, as it applies to FSS workstations, will increase Flight Service Specialists' productivity and improve system efficiency, reliability and availability.

- A significant improvement in flight planning and aeronautical information service to the pilot will be achieved through introduction of direct access, "one-stop" service for flight plan filing, Notices To Airmen (NOTAM), weather, and the status of airports and navigational facilities.

- Both quality and timeliness of flight information will be improved through an upgraded aeronautical fixed telecommunications network providing access to more up to date data banks.

- Inflight access to weather information will be enhanced through the establishment of an enroute weather advisory service operating on a common frequency.

Flight planning efficiency will increase with the pilot's ability to access directly flight planning information without assistance from flight service specialists. This information will be provided by regional aviation weather and aeronautical data bases. Automation of the flight service system will be accelerated over the next 10 years to enable consolidation of Flight Service Stations and to realize the operating and cost benefits of automation.

1.6.3 AVIATION WEATHER SYSTEM

Provision of accurate and timely weather information is essential for the planning and conduct of safe and efficient flight. The main source of weather data is through manual observations. These data are collected and processed into aviation weather forecasts by the Atmospheric Environment Services (AES). Weather forecasts are disseminated to users by various means, such as by telephone and direct contact with weather briefing specialists. This labour intensive means of weather observations and dissemination is inefficient and not cost effective.

To provide improved access to aviation weather information, the major thrust in the plan for Aviation Weather Systems is in the application of automation. Priority will be given to the following:

- Automatic Weather Observing Systems (AWOS). About 300 systems will be implemented to provide increased observations from all areas of Canada.

- The quality of aviation weather forecasts will be improved through the provision of greater coverage, by more numerous observations available through the AWOS, and by integrating weather data from other sources such as radars and satellites.

- Dissemination of weather data will be improved by providing users direct access to Transport Canada aviation weather processors. User-friendly and easily interpretable terminals will be the principal means of access to the most up-to-date weather data.

Action required by the pilot to obtain appropriate weather for his flight will be streamlined. In geographical areas where a high volume of general aviation, such as flight training or pleasure flying, is prevalent, mass dissemination of aviation weather information will be introduced. Development of TC aviation weather processors connected with the AES central computer will enable the routing and processing of data, obtained from the large numbers of automatic weather observing and reporting stations, through to the automated display terminals used by FSS briefers and air traffic controllers. Eventually these terminals will be developed into direct user access terminals. This will permit the pilot to access the aviation weather data to select a flight profile optimized for existing weather conditions, and subsequently to file his flight plan.

Strategic air traffic control, whereby advanced optimization of flight profiles will be effected, will be facilitated by the provision of accurate wind vectors from the new weather processors.

1.6.3 AVIATION WEATHER SYSTEM Cont'd

In areas of high-density traffic, a combination of AES, DND and TC radars will provide effective weather coverage of routes in the lower altitudes and volumetric coverage at 18,000 feet and above. FSS workstations will also utilize the radar and satellite data to provide preflight and inflight weather advisory service.

1.6.4 GROUND TO AIR SYSTEM

Ground-to-air systems include communications systems, enroute and landing navigation systems and surveillance systems. The major developments in ground-to-air systems outlined in the plan emphasize the following:

- Completion of modernization programs to eliminate older tube type equipment in order to obtain reliability at lower operating costs.

- Introduction of remote maintenance monitoring concepts and equipment so that travel to remote sites can be reduced and equipment conditions can be determined and corrected from central maintenance locations.

- Consolidation of facility locations to minimize the requirements for real estate, reduce maintenance costs and integrate coverage volumes provided by navigation, surveillance and communication installations.

- Implementation of new systems such as Mode S secondary surveillance radar with data link, Microwave Landing System (MLS) and satellite/HF data link which will improve the capability of the system to absorb additional traffic levels safely and efficiently while maintaining or reducing operating and maintenance costs.

- The different solutions required to meet the different needs within the Canadian environment between high and low areas of traffic demand.

Communication improvements will focus on replacing obsolete vacuum tube type equipment with solid-state technology. Additional communication facilities will be provided, particularly in northern areas. Installation of remote maintenance monitoring for communication systems and conversion of communications equipment to 25 kHz channel spacing capability will be completed. High frequency (HF) communication facilities will be converted to solid-state. Total VHF communication coverage at 12,500 feet and above in the high density traffic area will be completed. Consolidation of compatible communications, navigation and radar equipment into common buildings will be carried out where cost savings and improved reliability can be achieved.

Navigation systems developments will see the completion of a VOR-DME network which will ensure that navigational coverage is consistent with the coverage provided by surveillance radars in the high density traffic area. Similar coverage from communications systems will be available. Outside of radar coverage in the low density traffic area increased use of Omega will be encouraged by supplementing coverage with one or two VLF stations. The concept of required navigation performance capability for operations at and above 18,000 ft. in the low density traffic area will be adopted. Increased use of NAVSTAR (GPS) can be expected as the satellites become operational and civil avionics becomes less expensive.

1.6.4 GROUND TO AIR SYSTEMS Cont'd

Landing systems development will see the complete replacement of the Instrument Landing System (ILS) by MLS by the end of the period and the implementaion of category III operations at a small number of the busier airports. Withdrawal of ILS at international airports will take place on or about January 1, 1998. Earlier withdrawal of domestic and international systems may occur as early as January 1st 1995 subject to domestic requirements and/or international agreements. Existing non-precision approach systems will continue to be utilized and will be supplemented by DME. As ILS is withdrawn from service the locator NDB's will be retained to preserve the non-precision approach on that runway.

Surveillance systems development will see the replacement of all existing radar systems, both primary and secondary, and the incorporation of SSR Mode S data link in the enroute secondary surveillance radars. The weather surveillance data provided by the primary ATC radars will be combined with the AES weather radar network, which will include 3 DND radars, will improve the real time weather picture for pilots, controllers and flight service specialists. Total coverage by these systems will be provided in the high density traffic area at and above 18,000 ft. and in heavily utilized areas at and above 12,500 ft. Below these altitudes coverage will be available in terminal control areas. In low density traffic areas, at and above 18,000 ft., surveillance will be provided by relaying airborne derived navigational information via a satellite/HF data link.

Engineering development work will be carried out to establish the potential of satellites for communications, navigation and surveillance purposes.

1.6.5 INTERFACILITY AND INTRAFACILITY COMMUNICATIONS SYSTEMS

Interfacility Communication Network systems provide voice and data communications between air navigation and air traffic service facilities as well as voice and data communications within ATS facilities.

The plan emphasizes the following important aspects.

- As a portion of the Aeronautical Fixed Telecommunications Network (AFTN) the Canadian Aeronautical Digital Network (CADIN) will be established. It will interface with the FAA National Automated Data Interchange Network (NADIN) as well as with the Common ICAO Data Interchange Network (CIDIN).

- A mix of owned or leased, terrestrial and satellite communications techniques will be utilized.

- The system will take advantage of rapidly changing and lower cost technologies in telecommunications.

- The system will be characterized by a rationalized, reliable, efficient network. It will use state-of-the-art technology, multiplexing, automatic switching, alternate routing, high speed digital transfer and trunking.

- Replacement of costly single user communications systems with a total network will provide significant operating cost reductions.

- Fully integrated local area networks will be established within Air Traffic Service facilities.

The present basic data communications system for Air Traffic Services is the Automated Data Interchange System (ADIS), a low speed teletype network controlled by a central message switch. The ADIS is part of the Aeronautical Fixed Telecommuications Network (AFTN) with international links. The ADIS switch has been replaced allowing for the introduction of other types of data and higher speed lines. The system will evolve to include all data needs of Air Traffic Services. Further evolution will involve the digitization of voice, the installation of smaller switching nodes in each Flight Information Region to complement the central switch and increased use of satellite ground terminals. By the end of the planning period, voice and data communications will be fully integrated into a digitized total system called CADIN.

1.6.6 MAINTENANCE & SUPPORT SYSTEMS

Maintenance and Support systems include those auxiliary systems which are necessary for ensuring the continuing evolution, operation and performance of the Canadian Airspace System. The plan indicates the developments which will take place in the fields of maintenance, flight inspection, technical training, technical support and security.

The plan emphasises the following important aspects in which substantial cost-savings will be realized.

- New, reliable solid-state equipment will require less maintenance. Its stability and performance predictibility will permit application of new, more efficient maintenance concepts and provide greater equipment availability.

- Modern computer technology will permit the introduction of Control and Performance Monitoring systems, which will support the introduction of new, more efficient maintenance concepts and will enable the monitoring and analysis of equipment performance to be carried out from central locations.

- One of the capabilities of the Control and Performance Monitoring System will be monitoring of the long-term performance of the Canadian Airspace systems. By application of trend analysis, procedures and methods will be updated to maximize the efficiency and effectiveness of maintenance.

- Introduction of automated airborne equipment and new aircraft will allow for flight-evaluation of ground facilities under all weather conditions and with significantly improved efficiency.

- Computer Assisted Learning techniques will be introduced in the field for the training of operation and maintenance personnel, thus minimizing training costs.

- To accomodate engineering development and field support a Technical Systems Centre will be established, enabling common services and equipment to be shared and used more effectively.

- Significant improvements will be made to all aspects of the present Canadian Airport Security System (CASS).

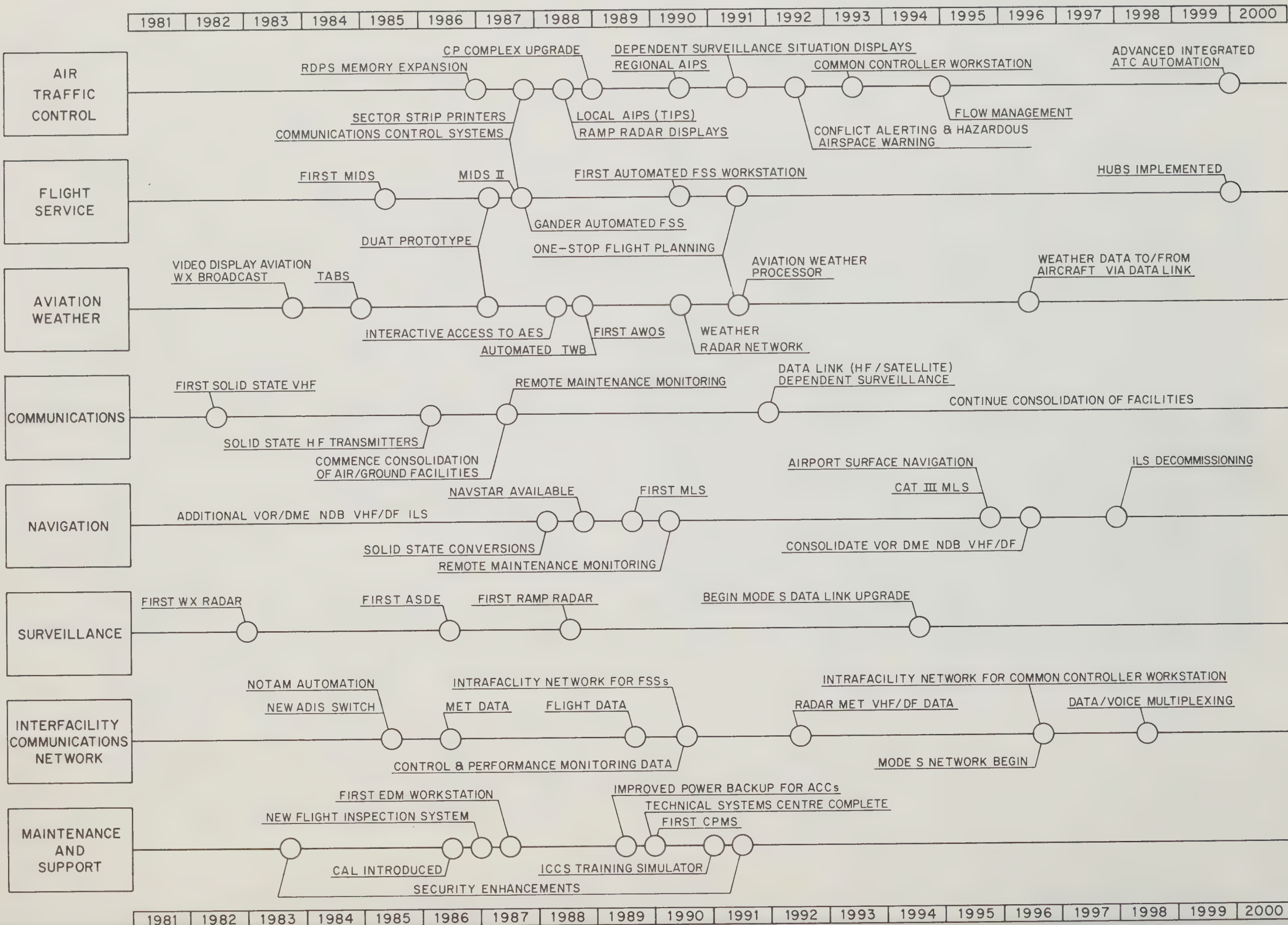
The introduction of the foregoing changes will increase the efficiency of evaluating and maintaining the Canadian Airspace System. Equipment improvements and the use of state-of-the-art computer-based technology will improve the reliability and availability of equipment and minimize the growth in person-years required for operations and maintenance.

1.6.7 ENGINEERING DEVELOPMENT

The Canadian Airspace Systems Plan (CASP) identifies a significant number of projects to be undertaken to provide the air navigation system of the year 2000. For most of these projects, advance work is necessary to determine operational and technical requirements, develop standards, investigate alternatives, build and evaluate prototypes and prepare implementation specifications. The CASP engineering development consolidates these activities and effectively coordinates all required efforts to produce a well-focused program. In keeping with the philosophy of the CASP, it supports the application of proven technology for minimum risk. Overall, the engineering development provides a definition and direction to the CASP implementation.

The projects described under Engineering Development relates to the Communication, Navigation and Surveillance (CNS) systems, the associated information processing systems, the security systems, and the maintenance systems outlined in the other chapters. Some advanced investigations are included to prepare for the acceptance of a few emerging technologies expected to mature before the CASP is fully implemented. Some projects previously underway, will continue to be pursued and will yield considerable short term benefits. The main thrust of all of the engineering development projects is to improve the utilization of available resources and to enhance reliability, maintainability and safety of the total air navigation system.

FIGURE I.1. SYSTEMS EVOLUTION



1.7 BENEFITS OF THE PLAN

The implementation of the Plan is expected to achieve the following:

OPERATIONAL CAPABILITY

The resulting system will consistently meet user-demand for planned, conflict-free, fuel-efficient flight profiles. Flight operations with a minimum of constraint and with the highest practicable fuel-efficiency will characterize the system. Dynamic flow management will reduce airborne delays. Safety will be enhanced through the application of automation techniques and systems redundancy.

Pertinent current weather information will be available to pilots, controllers and flight service specialists.

Automation will minimize the number of operations personnel required.

TECHNICAL CAPABILITY

Automation, navigation, surveillance, and landing systems will employ state-of-the-art technology. Unique equipment types at air traffic service facilities will be replaced and the logical grouping of compatible functions with standardized communications, computer and display elements will be used where practicable to achieve efficiency and economy. An efficient communications network will support individual facilities. Costs will be reduced through consolidation and automation of Flight Services and, whenever practicable, through consolidation of communications, navigation and surveillance facilities. Reduced maintenance will minimize the number of maintenance personnel required.

PRODUCTIVITY

Implementation of the Plan will achieve improvements in the productivity of personnel. Due to the consolidation of some facilities, the implementation of solid-state equipment and increased levels of automation, operating and maintenance costs will be significantly reduced without incurring any degradation in service.

1.7 BENEFITS OF THE PLAN Cont'd

SAVINGS TO THE USER

Implementation of the Plan will result in more efficient systems which will lower the cost of providing services. Savings to users will result from enhanced flight safety, a reduction in delays and improved fuel-efficient pilot-preferred routing. A study has already shown that the total operating cost savings to Canadian commercial carriers operating domestically on stage lengths of 400 nautical miles or more, if granted optimum routes in 1982, would have amounted to $10.5 million. The commercial traffic overflying Canada would have realized a saving of $28.8 million in 1982.

As the improvements detailed in the Systems Plan begin to take effect, evolving towards the final goal of granting optimum ATC clearances, the user of the system will begin to realize substantial savings proportionate to the degree of implementation of the Plan.

1.8 IMPLEMENTATION OF THE PLAN

1.8.1 THE IMPLEMENTATION TASK

The activities described in the Plan are large and complex, and are driven by the users needs for services, the systems' operators defined performance requirements, the requirement to replace ageing equipment and the pace of new technological developments. The implementation process is almost overwhelming in its magnitude.

To successfully implement these activities, the long-term support of the aviation community and the public is mandatory. The continued support of aviation users and the public depends on delivery of some benefits in terms of enhanced safety, improved services, or reduced operating costs early in the implementation period. Achieving these early benefits will require a very carefully orchestrated integration of project outputs.

During the life of this modernization activity, the operational performance requirements will change. These changing requirements will be the result of changing demands placed on the system or the emergence of changed or new technology. Provisions must be made in the implementation strategy to accommodate these changes even as the program is moving forward.

There are literally thousands of Air Traffic Control and Air Navigation components comprising the Canadian Airspace System. Some are to be retained, others are to be modified, and some are to be replaced in the modernization. All are providing critical services to the Canadian aviation community. Those services must not be disrupted during implementation activities.

The projects comprising the Canadian Airspace Systems Plan are in various stages of implementation. Some are currently being installed in the field, others are in production, others are being planned, and some are yet to be developed. Those activities nearest to completion are those which can be changed the least (without disrupting the entire program) and those which are the furthest from completion are most likely to change. Although this reality is a significant constraint on any implementation scheme, it must be accommodated.

The effect of all of these diverse and sometimes conflicting requirements on the implementation process have mandated the adoption of a formal Systems Engineering discipline in order to assure realization. Without this approach, there is little chance of successfully implementing the Plan in any reasonable time-frame and at any reasonable cost.

1.8.2 SYSTEMS ENGINEERING PROCESS

The classical approach to project engineering is one in which planning, design, project execution (production), implementation, and maintenance and operation are performed serially as depicted in Figure 1-2. There is no question as to the efficacy of that approach when satisfying requirements with a single project.

CLASSICAL APPROACH TO PROJECT ENGINEERING

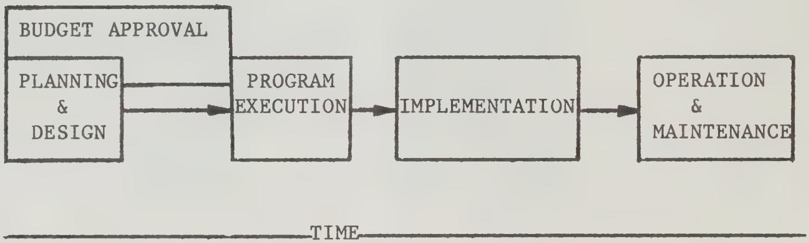


FIGURE 1.2

Unfortunately, the Aviation Group is not faced with requirements which can be satisfied with a single project, but rather with requirements which generate a large number of generally complex, and usually interrelated projects.

There are three significant factors which further complicate the situation. First is the fact that each of the projects identified must relate in some unique way to the existing operational system; second, each of the projects is in a different state of completion; and third, outputs must be implemented into an operating system without causing a loss of service.

To address this, a total systems approach to Systems Engineering planning is being implemented. The strategy involves a four-tiered approach to the development of complete System Designs that are responsive to those requirements. This tiered or layered approach permits requirements identification activities and systems design to proceed both in series and in parallel. The first tier, or Level 1, sets out the functional requirements and the allocation of these to system components. Level II translates the allocated functional design to a topological description of "what goes where", while Level III describes "what goes where" at selected points in time (to ensure a smooth and efficient transition from the existing system) and Level IV comprises actual site designs. Under this scheme, the overall program design guides project activity. Projects do not proceed independently but are harnessed to an overall program plan.

All four design levels undergo refinement on a concurrent basis as the program evolves. This avoids the time delay that would be incurred with a purely sequential approach, while allowing a mix of top down and bottom up planning. This approach also allows the design to respond to technological advances as well as changes in requirements and political factors while ensuring that the basic integrity of the design is preseved (i.e. projects accord within an overall program design and the implementation is timed to maximize near term benefits while minimizing the need for costly interfaces or modications to completed systems).

Within each level, performance and design are set out in progressively increasing levels of detail. This enables performance definitions to be progressively elaborated as the planning, design and execution of the Canadian Airspace Systems Plan moves forward.

It is through this Systems Engineering process that the functional allocation to project activities occurs. The specific projects are then considered as a set to ensure that when they are taken together they fully address the validated requirements without overlaps or gaps and that they represent the smallest set of facilities or systems which will satisfy the total requirement.

1.9 CAPITAL REQUIREMENTS

Over the past several years considerable expansion of the existing equipment base has been necessary to keep pace with increasing demand. Although some upgrading and replacement has been carried out most of the equipment base is in need of replacement. To meet projected user demands whilst ensuring that there is no reduction in service, a large amount of capital is required to upgrade and modernize facilities and equipment of the Canadian airspace system. While these capital expenditures are necessary with or without the plan, the total integrated systems engineering approach presented in this plan ensures maximization of benefits both for the Transport Canada Aviation Group and the users.

A capital expenditure of $5.0 billion to the year 2000 is identified under this plan, and allocated as follows:

	$MILLIONS CURRENT
MAJOR CROWN PROJECTS	
RAMP	811
MLS	381
FDMP	276
CPMS	315
FISA	370
AIPS	200
	2353
MAJOR PROJECT AREAS	
Flight Calibration	100
Communications	370
Navigation	425
Surveillance	300
Automation	300
Telecommunication Network	295
Common Controller Workstations	260
Aviation Weather	287
Maintenance & Support	125
Developmental	85
Systems Engineering	100
	2647
TOTAL EXPENDITURE	$5.0 Billion

1.9 CAPITAL REQUIREMENTS Cont'd

EXPENDITURE SCHEDULE	
YEAR	MILLIONS $CURRENT
Previous	120
1985/6	119
1986/7	167
1987/8	320
1988/9	305
1989/90	320
1990/91	294
1991/92	306
1992/93	306
1993/94	330
1994/95	355
1995/96	375
1996/97	395
1997/98	412
1998/99	425
1999/2000	451
	5000

1.10 THE PLAN AND TECHNOLOGY-BASED OPTIONS

1.10.1 GENERAL

The critical question in developing the Plan was not which technology could be applied but which technology should be applied considering that changes would have to be made in an evolutionary manner and in accordance with the objectives of achieving economy, increasing productivity and providing adequate capacity, without degrading safety.

As the Plan shows, to meet the above objectives it will first be necessary to introduce more automation in the ATS system in order to exploit space-based technology economically and effectively. Along with this thrust, systems integration, and to the extent practicable, consolidation of ATS and engineering facilities, will also be instituted to take full advantage of technology. In the case of ground to air systems, that is, the systems which address the functions of communications, navigation and surveillance, a comparison of space-based and terrestrial techologies was carried out and is summarized below.

It should be noted that ICAO recently established the Future Air Navigational Systems (FANS), a Special Technical Committee of Council, to develop a projection of international civil aviation's air navigation requirements over the next twenty-five years. In effect, the Canadian Airspace Systems Plan and ICAO's initiative are complementary. To ensure continuing consistency, close coordination will be maintained between ICAO's FANS activity and Canada's planning initiatives for the adoption and use of space technology in air navigation systems.

1.10.2 SPACE TECHNOLOGY OPTIONS

Introduction

Following the termination of the AEROSAT (Aeronautical Satellite Program), and prior to the establishment of FANS, an international body known as the Aviation Review Committee (ARC) completed a report in 1982 concerning, amongst other matters, the strategy for the use of space technology for civil aviation. The report concluded that owing to the high cost of dedicated satellites for communications, the use of shared satellites was the preferred economic option for civil aviation in the foreseeable future (to 2005).

The FANS Committee's terms of reference require that a detailed analysis be carried out which will identify a blue-print for international civil aviation. Canada is a member of this committee. A major part of the committee's work program is the determination of the application of satellites for civil aviation in the context of the functions of:

- Communications
- Navigation
- Surveillance

Whilst it is technologically feasible to adapt space technology to perform these functions, their world-wide use will be governed by several key factors such as economic and cost-effectiveness considerations, institutional arrangements within ICAO, the phasing out of the existing navigation and surveillance infrastructure and its replacement by space-based systems; user acceptance and investment in appropriate avionics, and international (ICAO) agreement on standards.

Navigation

At present, the leading space-based candidate system for air navigation is NAVSTAR/GPS, a U.S. military system. This system relies on a configuration of 18 plus 3 spare orbiting satellites to provide complete global coverage. Its positioning accuracy, without the P code, is 100 metres 2d rms.

NAVSTAR/GPS has been included in the long range radio-navigation plan of the United States and extensive R&D is being carried out to produce a low cost (less than $500.00) NAVSTAR receiver. International acceptance of the NAVSTAR/GPS will probably follow the same pattern as other systems that were originally deployed by the United States for restricted (military) use but which eventually became and still are widely used, such as LORAN. The United States has advised ICAO, through the FANS committee, that it has no plans to have NAVSTAR/GPS submitted to ICAO for international standardization. It is, therefore, not possible to determine whether ICAO will consider the world-wide use of such a system for civil aviation or whether it will decide that a system which is not tied to any particular State is preferable and if so, what the mechanisms will be for developing (capital costs), deploying and using (operating and maintaining costs) such a system. These are the types of problems being analyzed by the FANS committee.

1.10.2 SPACE TECHNOLOGY OPTIONS Cont'd

The European Space Agency is studying the use of a civil satellite navigation system, which is still in the early stages of development. Additional studies to determine the cost-effectiveness of combining the Communications, Navigation and Surveillance requirements in one satellite system are also being carried out.

Considering the number of options, the need to develop standards, establish institutional arrangements and resolve other related matters in ICAO, it is not likely that such systems will be in widespread international use by civil aviation before the year 2000. It is expected that pre-operational evaluation of systems will take place in the 1990's.

Surveillance

The use of satellites in automatic dependent surveillance (i.e. the automatic relaying of the position of an aircraft derived from its on-board navigation system down to the ATC system is being considered by the FANS Committee for civil aviation, particularly in those areas where a ground-based sensor (such as PSR or SSR) is either economically or physically not possible. Used in conjunction with the ICAO approved airborne collision avoidance system, it offers a safe, operationally viable and cost-effective means of providing ATC with surveillance of air traffic over oceanic and sparsely populated areas. From overall economic considerations, dependent surveillance has attractive cost benefits since it exploits existing aircraft navigation equipment and does not require the fitting of additional avionics. However, until such time as satellite surveillance can attain position update rates comparable to those of PSR/SSR ground-based sensors, its use in high density traffic areas will be limited. In airspace within which not all aircraft are suitably equipped to receive dependent surveillance its use will also be limited. In addition to relaying an aircraft's position, the same satellite system can also be used to support other air-ground communications. In this Plan it is one of the options proposed for use in the Low Density Traffic Area.

Communications

The Space-based system used for surveillance can also support other air-ground data link communications. This would include weather, clearance delivery and other standard air traffic service messages.

1.10.2 SPACE TECHNOLOGY OPTIONS Cont'd

Communications Cont'd

Because of its bandwidth (channel) requirements, the use of the satellite system to provide air-ground voice communications is costly. It requires ten times as much satellite power as a low data rate (200-400 bit per second) channel and any increase in transmitter power increases the cost of avionics. However, because of developments such as speech encoding and by combining the functions of navigation, surveillance and communications, the long term future use of satellites will likely lead to more cost effective air-ground voice communication.

Satellite communications will continue to be used for the fixed point-to-point service wherever cost effective. In addition, they will be used to collect data from remote automated weather observing stations. One such system now under development by Canada's Department of Communications, called M-SAT, will be capable of collecting data from unattended stations.

1.10.3 TERRESTRIAL OPTIONS

Given the unlikeliness of widespread use of satellite technology for ground to air systems prior to the year 2000 the plan primarily proposes ground based solutions to communications, navigation and surveillance. The solutions proposed recognize the responsibility of Transport Canada for providing an infrastructure to serve all classes of aviation while minimizing, to the extent practicable, the costs. The solutions therefore represent a balance between direct costs to Transport Canada and to the user and recognize the different needs exhibited by the High and Low Density Traffic Areas. Further, the solutions represent a moderate approach to expansion of systems over the next fifteen years and recognize the probability that space technology may well become an important factor toward the end of the period. It should be noted, however, that the Plan caters for the co-existence of space-based and terrestrial systems during the transition period. Satellite technology will continue to be evaluated and cooperative international programs will be undertaken to keep Transport Canada abreast of developments and ready to adapt to international needs.

NAVIGATION

Options for navigation were considered in the context of the existing infrastructure which now provides significant VOR-DME coverage in the High Density Traffic Area, but is based primarily on the use of NDB's in the Low Density Traffic Area. Also, in order that more fuel-efficient flight profiles for all classes of aviation could be achieved the provision for area navigation both in the Low and High Density Traffic Areas was considered to be a high priority need. INS and OMEGA are now being utilized by aircraft flying in the MNPS airspace which has been established in the Low Density Traffic Area.

In the High Density Traffic Area, given the existing network of VOR-DME's providing airway coverage, the main option considered was to continue expansion of this network for the purpose of enhancing the airway system or to lower MEA's, where cost justifiable, and to provide for area coverage at higher altitudes where suitably equipped aircraft, using area navigation, can be accommodated. It needs to be stressed that the confirmation of the VOR-DME option in this airspace does not preclude the acceptability of other options, where applicable, for suitably equipped aircraft. This, of course, means that self-contained systems such as INS and ground referenced INS/DME systems as well as OMEGA and Loran "C" navigation will be permitted in the High Density Traffic Area under the right conditions. The infrastructure which Transport Canada proposes would therefore continue to conform with the ICAO standard of VOR-DME backed up by the existing low frequency enroute NDB network. Implementation will be subject to cost/benefit analysis.

Loran "C" as the primary option was rejected because of the cost to provide area coverage throughout the High Density Traffic Area (largely duplicating existing VOR-DME coverage) since present coverage is confined to the east and west coasts and the Great Lakes areas.

1.10.3 TERRESTRAL OPTIONS Cont'd

Omega was not considered the preferred option for the High Density Traffic Area because its accuracy will not always meet ATS route requirements without the addition of VLF/NAV stations to augment the OMEGA coverage and geometry in Canada. Inertial Navigations Systems are a viable and acceptable option of the aircraft user.

In the Low Density Traffic Area the selection of options is not so clear because complete VOR-DME coverage is not currently available and expansion of the present VOR-DME network in this area to provide area coverage would be prohibitively costly. It is estimated that at least twenty-five installations would be necessary at a cost in excess of $50 million with additional significant increases in operating costs. The need for provision of area coverage is primarily related to high level North Atlantic traffic and associated reduction of air traffic control separation in conjunction with minimum fuel routings. Long range area navigation is currently performed primarily using inertial navigation systems (INS) and/or the OMEGA system. It was considered that by exploiting these two systems, benefits could be provided both to high level and low level flight at a relatively low cost.

LORAN "C" was also rejected as an option for providing area navigation coverage in the Low Density Traffic Area because of the considerable cost involved (estimated to be many times greater than the cost of the OMEGA/VLF described below).

In the case of OMEGA, improvements to this system are necessary in certain areas of Canada because of poor geometry as a result of attenuation of the Norway signals over Greenland and unusability of Liberia signals at certain times. This can be achieved by installing one or two complementary VLF stations which could be utilized by most existing OMEGA navigators. The OMEGA/VLF combination is of benefit to both high and low level traffic. The proposed option therefore incorporates one or two VLF stations. Although airborne OMEGA navigation installations may be considered expensive at this time the expectation is that costs will decrease as demand increases and that the benefits from utilizing OMEGA in the Low Density Traffic Area will allow operators to achieve cost benefits. The concept of providing lower quality VOR installations for the Low Density Traffic Area is considered to be an undesirable option because ICAO requires VORs to meet certain standards and because the costs would undoubtedly be significantly higher than the proposed option.

1.10.3 TERRESTRAL OPTIONS Cont'd

SURVEILLANCE

In like manner to communications, there is little scope for exploitation of any new options in the realm of high capacity air traffic surveillance. The High Density Traffic Area demands the continued use of primary and secondary radar with their high capacity ability, enabling the use by ATC of lower separation minima. Improved secondary radars, replacing the older installations, are a part of the approved RAMP program and future enhancements provide for inclusion of SSR Mode S capability. SSR Mode S improves surveillance accuracy to support automation enhancements, provides interference-free aircraft identification and altitude data and eliminates code garbling occuring today in high density areas. It will also permit two-way ground-to-air data link. This will enhance safety and increase productivity in ATC operations by providing a back-up to Voice Communications and enabling the display of weather data direct to the cockpit. SSR Mode S is fully supported by ICAO and the FAA's SSR Mode S program is being implemented.

In the Low Density Traffic Area, where installation of SSR Mode S would be prohibitively costly (if satellite data link communications are not used) "dependent" surveillance using HF datalink position reporting is the only option available and is proposed in the Plan. The lower capacity of this means of surveillance is acceptable in areas of lower traffic density.

COMMUNICATIONS

There is little scope for exploitation of options in the communications field when considering ground based systems. The primary communication frequencies will be in the VHF band for direct ground to air contacts. Since VHF frequencies require line of sight between the ground station and the aircraft, certain geographical areas are difficult or even impossible to cover. For this reason HF communications will continue to be available for long range applications and for gap filling purposes in the Low Density Traffic Area.

The two options available using these media are the transmission of voice or data. The present system is totally based on voice transmissions. The gradual shifting of emphasis from voice to data transmission will permit improvements in communications efficiencies, reduce communication errors and increase the reliability of communications particularly at HF frequencies. The extended use of data transfer from suitably equipped aircraft will permit positive ATC surveillance in areas beyond radar coverage and thus improve service through reduced aircraft separation criteria and minimum fuel routings/profiles.

1.11 CONCLUSION

This plan identifies the capital investment required to modernize and consolidate the Canadian Airspace System, the major systems engineering development and the facilities and equipment acquisition programs to accomplish it, the strategy to carry it out and the major decision facing the Aviation Group to ensure its success.

The plan will:

- Permit evolution to an integrated system.

- Ensure no degradation or loss of existing services.

- Improve services where deficiencies exist.

- Accommodate foreseeable traffic levels and a wide range of demands for services.

- Minimize future staffing levels and operations and maintenance costs.

Implementing the plan will be expensive and will proceed more slowly than many would wish. However, the sheer magnitude of the task, along with the technological innovations required to avoid early obsolescence, and the need to constrain expenditures make the plan practical.

In order to be executed efficiently, the plan will be periodically updated in its detail, amendments being made in response to changes in demand, user requirements or to the impact of new technology. There is a need for a continuing committment to the funding levels to ensure that each component of the restoration program evolves in a timely manner, into the total integrated system.

CHAPTER 2

DEMAND ON THE SYSTEM

CHAPTER 2

DEMAND ON THE SYSTEM

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TABLE

ILLUSTRATIONS

FIG.

2.1 INTRODUCTION

This Chapter provides a brief look at the factors affecting future demand, provides the latest forecast demand indicators, reviews the air traffic demand for airports and airspace; and concludes with a review of the expected utilization of airborne equipment.

2.2 FACTORS AFFECTING FUTURE DEMAND

Forecasts provided by the Policy and Strategic Planning Directorate are the short to medium term outlook for five key aviation industry indicators of demand for the Aviation Group's facilities and services as follows:

- enplaned and deplaned passengers
- enplaned and deplaned cargo
- itinerant aircraft movements
- registered aircraft with a valid certificate of airworthiness
- licenced personnel

The latest forecasts have been prepared in an environment characterized by considerable change and uncertainty. Two forces in particular are expected to continue to have a major impact on aviation demand. These are (a) the nature and pace of the post recession economic recovery in Canada and (b) the reduction of economic regulation of the domestic air industry. A brief outlook for both of these factors is presented below.

Economy

The single most important factor influencing air demand, is the general state of the economy, as this determines both the extent of business travel and the public's ability to afford discretionary travel. Historically, an expanding economy has meant increasing demand for air travel for both business and non-business purposes, with the response of air travel demand lagging major shifts in the economy from six months to a year.

The slow-down in economic growth experienced during 1985 is forecast by the majority of leading economic forecasts for Canada to continue into 1986. In 1987, they predict that the economy will likely cycle back to a period of accelerating growth. While it is very difficult to forecast the exact pattern of economic cycles beyond this point, it is expected that the average real annual growth rate for the Canadian economy will be between 2.5% and 3% into the early 1990's.

In summary, the Canadian economy has now recaptured the ground lost during the recent recession. It is expected to continue to grow throughout the remainder of the decade, although at a rate considerably below the rate of economic expansion experienced during the 1960's and 1970's. Growth in aviation demand can be expected to continue to parallel this economic growth.

2.2 FACTORS AFFECTING FUTURE DEMAND Cont'd

Regulatory Reform

On May 10, 1984 a new Canadian domestic air carrier policy was announced which was aimed at reducing the economic regulation of the air carrier industry in Southern Canada to the extent possible under existing legislation. Specifically, from among the measures taken, the policy removed restrictions from air carrier licences, encouraged carriers to apply for licence consolidation, asked the CTC to give greater weight to the benefits of competition, and envisaged full downward price flexibility for carriers by 1986.

It was assumed in preparing forecasts, that the process begun of reducing the regulatory burden on the air transport industry will continue. It was also assumed that, in general, the impact of deregulation will be to slow the growth of costs and prices in the industry, promote productivity gains, and stimulate cost, price and service innovations. These impacts however will not be uniformly felt across the system, but rather will vary according to market forces.

2.3 THE FORECAST DEMAND INDICATORS

2.3.1 Enplaned and Deplaned Passengers

Estimated traffic growth in 1985 (4.5%) and expected growth in 1986 (5.4%) is somewhat stronger than economic growth alone would suggest. This is the result of the regulatory reform which stimulates more competition, lower fares on certain routes and hence generate more traffic than might otherwise be expected. With this growth pattern, it is expected that the 1980 traffic volume, the previous high, will be reached again in 1986. Growth in the second half of the 1980's (in the order of 4.5% per annum for the period 1986-1991) reflects the economic growth expected (2.9%) and the long run stimulative impact of the present air carrier policy. Total mainline unit toll and international charter traffic in 1991 at the "Top 30" airports is forecast to reach 61 million enplaned plus deplaned passengers.

The growth rate of total traffic 1983-1991 is expected to be slightly higher than that for mainline unit toll and international charter at the top 30 airports. This is because other unit toll carriers are expected to experience higher growth in demand as a result of the regulatory reform policy. They are expected, in particular, to significantly increase their market shares. In spite of this growth in the other unit toll, mainline carriers will continue to carry more than 90% of the total demand for the entire forecast period.

The 1985 and 1991 estimates are as follows:	1985	1991
Mainline Unit Toll & Int. Charter enplaned and deplaned passengers:	46.6M	61.0M

2.3.2 Enplaned and Deplaned Cargo

After three years of declining traffic which saw E & D cargo drop 6.2% from 1979 to 1982, traffic increased significantly in 1983 (7.4%) and 1984 (11.9%). This resurgence reflected the economic recovery underway both in Canada and internationally and the strength of the Canadian dollar relative to European currencies which has encouraged a particularly high volume of North Atlantic air cargo.

The future for air cargo appears good for a number of reasons, including:

- the present domestic air carrier policy which is expected to stimulate cargo as well as passenger traffic;

- international traffic is expected to continue to show strong growth, particularly the Pacific market, reflecting the strong growth in Pacific Rim economies (especially in regard to computer/electronics technology);

- continuing high interest rates and thereby high carrying charges for inventories are leading businesses to turn to air cargo as a means of keeping these costs down.

Driven by these factors, enplaned plus deplaned mainline unit toll plus international charter cargo growth is forecast to grow at 5.8% per annum between 1983 and 1991.

The 1985 and 1991 estimates are as follows:	1985	1991
Enplaned & Deplaned Cargo (Tonnes)	591,000	689,000

2.3.3 Itinerant Aircraft Movements at Controlled Airports

Air carrier aircraft movements during the 1970's have generally grown at a rate below that of the passenger demand, reflecting increasing load factors and larger aircraft. The trend toward a steady increase in average aircraft size is no longer expected to continue as airlines seek to acquire and increase the utilization of medium size aircraft in order to offer higher frequency and more competitive service (in part as a result of the present policy).

Average loads on air carrier aircraft increased, particularly in the late 1970's, and peaked in 1980. During the recession, the significant drop in passenger demand temporarily reversed this trend, however in 1984, as the country emerges from the recession the system load factor has reached a record high. The present policy, when it takes hold, is expected to bring average loads slightly down in the short term as a result of intensified competition. However, average load factors are forecast to return to high levels during the second half of the 1980's, due to increasing pressure to reduce costs.

2.3.3 Itinerant Aircraft Movements at Controlled Airports Cont'd

The forecast of air carrier movements is based on the forecast of passenger demand described earlier and takes into account the assumption on load factor and aircraft size described above. The result is a forecast of fairly rapid growth in the short term as passenger demand is stimulated by real declines in fares and as carriers increase frequency of service to gain or maintain market share, allowing load factors to fall. In the longer term, the growth in air carrier movements is expected to stabilize at a much lower rate, resulting in an average growth rate of 4.2% per annum between 1983 and 1991.

The 1985 and 1991 estimates are as follows:

	1985	1991
Air Carrier	932,000	1,130,000
G.A.	2,099,000	2,700,000
Total	3,031,000	3,830,000

General Aviation (GA) itinerant movements comprise the majority (70%) of itinerant aircraft movements at the controlled airports. The General Aviation traffic forecasts are derived as a function of the state of the economy and the cost of flying.

Itinerant GA movements increased by 100.0% between 1971 and 1980. More recently, traffic dropped significantly between 1980 and 1983 (26.2%). This downward trend was halted in 1984 by the economic recovery and the average annual growth rate predicted for the period 1983-1991 is 3.0% per annum. Unlike the 1984 ADI forecasts which called for a strong resurgence of GA activity, indications now point to a much more gradual increase.

Combining Air Carrier and General Aviation forecasts, the resulting forecast of the growth in total itinerant aircraft movements at the controlled airports is 3.5% per annum for the period 1983-1991.

Itinerant movements at all airports reporting to Statistics Canada are slightly more than one third greater than the volume at the controlled airports. Aircraft movements at all airports are predicted to grow at 3.4% per annum between 1983 and 1991.

2.3.4 Registered Aircraft with Valid Certificate of Airworthiness

The aircraft fleet is composed of two distinct elements: the air carrier component, which comprises about 25% of the fleet and the general aviation component, which comprises the remainder.

The air carrier and commercial general aviation fleets are projected to grow 9% during 1983-1991. The private general aviation fleet is expected to grow 13% during the same period. The national total in 1991 will be 21,000.

2.3.4 Registered Aircraft with Valid Certificate of Airworthiness Cont'd

One other general aviation category to note is the "ultra lights" which do not require C of A permits but whose numbers have risen from insignificance to become 4% of the 1983 total. Growth in ultralights is expected to parallel the overall long term growth of total registered aircraft by 1986 as the market for this activity matures. This results in a forecast growth for the entire fleet of 2.1% per annum for the period 1983-1991.

The 1985 and 1991 estimates are as follows:

	1985	1991
Total	19,000	21,000
Commercial	4,580	5,000

2.3.5 Aviation Group Licenced Personnel

The number of licenced personnel has grown steadily since 1971, increasing by 77% between 1971 and 1983. Between 1980 and 1982, the increase was slowed to about 2% and there was actually a slight drop in 1983 (0.3%). The forecast for licenced personnel is for an average annual growth rate of 1.0% for the period 1983-1991.

While the number of pilots has increased steadily during the 1970s and early 1980s, and is forecast to increase at an average annual growth rate of 1.1% between 1983 and 1991, the number of student permits has decreased significantly since 1979 (16,658 in 1983 versus 24,847 in 1979). The current forecast indicates that the 1979 level of student permits will not be reached again until the end of the decade (1990/1991).

This indicator was developed using time series analysis along with assumptions on future aircraft demand and pilot supply. The forecast takes into consideration a slowdown in the number of student permits, reflecting the future diminution of the size of the population group 20-24 years who have constituted the major source of student fliers.

The national 1985 and 1991 estimates are as follows:

	1985	1991
Total licenced personnel	68,943	77,600
Pilots	60,175	67,900
Commerical Pilots	17,364	19,400
Students	13,931	20,000

2.4 AIRPORT DEMAND

There are presently 1298 civil airports (licenced aerodromes) in Canada - 621 land, 420 water and 257 Heliports. Of the 621 land airports 153 are owned by Transport Canada. 104 of these are operated by the Federal Government with the remaining 49 operated by other levels of government or private agencies for the Federal Government. There are also 48 aerodromes operated by the military.

Analyses carried out as a part of the development of the National Airports Plan have concluded that the air traffic demand at a few airports in Canada will exceed the runway capacity at varying times up to the year 2000. Current technologies and procedures are assumed in assessment of capacity. The capacity-deficient airports are those situated in the higher population densities and there is increasing resistance to the adverse environmental impact of airport growth in these areas. Because of this, and the expensive and difficult task of land acquisition for the enlargement of facilities or construction of new airports, expansion in these areas will be limited.

There are no long range plans for construction of any new international airports. However, application of good design development principles, an improvement in the Air Traffic Control infrastructure, with the possibility of a reduction in aircraft separation minima, improvements in landing aids, redistribution of traffic amongst the airports within a zone will assist in providing any required increase in capacity. Any remaining problem areas might eventually be forced into accepting quotas and flow control restrictions and could result in schedule changes for alleviating peak hour congestion. In the long term, the Systems Plan includes provision of a flow management system, the specific planning for which would commence only when the needs are clearly identified. Runway capacity is not perceived as a major problem in the same manner as, for example, in the United States, but the need for contingency must be conceded. Also, it must be recognized that any regulation of demand involves government policy, CTC, bilaterals, the Aeronautics Act and Regulations and orders pursuant.

2.5 AIRSPACE DEMAND

The geographical distribution of the major air traffic flows within Canadian airspace is directly related to the location of the main airports, situated in the proximity of the larger urban populations. These flows consist mainly of domestic traffic departing from one Canadian airport and arriving at another Canadian airport. Of the total itinerant movements at the 60 controlled airports in Canada, about 90 percent are domestic.

The remainder of the itinerant traffic of the 60 airports originates from or is destined for airports outside Canada. These flows are Transborder, Pacific, North Atlantic and Polar.

In addition to the aforementioned traffic of Canadian airport origin/ destination, there is the traffic which overflies Canada between Alaska and mainland USA, the North Atlantic and the USA and Polar regions and the USA.

The main concentration of traffic is roughly along two axes, Vancouver to Toronto and Newfoundland to Toronto. Short haul domestic flights tend to utilise the same route throughout the year, remaining close to the direct track between airports. The medium and long haul flights will vary their flight plan route, utilizing optimum routes between origin and destination according to the weather patterns and the performance characteristics of each particular flight profile. Taking account of these factors and of the variations in climb and descent performance of aircraft within the terminal airspaces there is a volume of airspace across the Southern part of Canada within which the majority of domestic flights flow. This high density traffic demand area is related to the two aforementioned axes but expands at the Atlantic and Pacific coasts, accommodating the additional flows of traffic in these areas. The remaining portion of Canadian Domestic Airspace is referred to as the Low Density Traffic Area. Both areas are depicted in Figure 2.1. Most IFR traffic in the high density area operates above 12,500 feet.

Finally, Canada has responsibility, through ICAO, for the provision of Air Traffic Services within the western portion of the North Atlantic Airspace. This area of air traffic demand is the Gander Oceanic Control Area, shown in Figure 2.2, containing mainly east-west flows of traffic, whose tracks vary daily according to the weather patterns between Europe and North America. The majority of this traffic flows to and from airports located in the United States, with a considerable portion of their flight profiles being within Canadian airspace. The remainder of the North Atlantic traffic originates from or is destined for Canadian airports. The majority of North Atlantic traffic operates above 27,000 feet.

All the aforementioned areas contain significant flows of traffic, the nature of which requires provision of an air traffic control system. In both the high and the low density areas, greater emphasis must be placed on strategic air-traffic management, by exploitation of automation for the provision of conflict-free, hazardous weather avoiding, fuel-efficient flight clearances. This will be achieved by the development of a fully integrated system of navigation, communications and surveillance facilities, supporting a computer-based air traffic control system.

2.5 AIRSPACE DEMAND Cont'd

ATC surveillance in the High Density Traffic Area is achieved by use of the high capacity SSR System. In the low Density Traffic Area (and Gander Oceanic) surveillance is achieved by use of the lower capacity position reporting (dependent) system. In the future, as the system needs to change from voice communications to data-link, SSR Mode S will be used in the radar environment and HF or Satellite will be used in the non-radar environment.

2.6 AIRBORNE EQUIPMENT UTILIZATION

Airborne equipment during the next two decades will be utilized within four categories:

- Navigation Systems
- Air/Ground Communications Systems
- Aircraft Separation Systems
- Approach and Landing Systems

Projected utilization of equipment within Canadian airspace during the next two decades is illustrated in Table 2.1.

NAVIGATION

Use of VOR/DME, a co-located very high frequency omni-directional range station (VOR) and distance measuring equipment (DME); area navigation systems, either the self contained Inertial Navigation System (INS), or those utilizing VOR/DME, LORAN C or Omega; and to a lessser extent, non- directional beacons (NDB) are expected to continue at least until the end of the century. More advanced systems of mapping and 4-dimensional area navigation should become commonplace by the year 2000. Satellite navigation is not forecast to be in widespread use.

The flight management system, an integrated system for flight guidance and control, will be standard equipment in new generations of transport category aircraft. The system design provides for three-dimensional navigation throughout the entire flight profile and growth capability to 4D navigation.

COMMUNICATION

Use a Very High Frequency (VHF) communications is anticipated to remain predominant throughout the period with the use of Ultra High Frequency (UHF) remaining limited. High frequency (HF) communications will continue to be used in the areas of non-VHF coverage, such as the north and the Gander Oceanic Control Area and will eventually provide the means of ground/ air data link in those areas. By the year 2000 there will be increasing use of data link systems utilizing SSR Mode S or HF. Although not expected to be commonplace, aeronautical satellite communications will also be increasing.

2.6 AIRBORNE EQUIPMENT UTILIZATION Cont'd

SEPARATION

The present Secondary Surveillance Radar (SSR) transponders will continue to be in widespread use until eventually being replaced by SSR Mode S transponders. A Traffic Alert and Collision Avoidance System (TACS) will provide an independent airborne collision avoidance capability.

APPROACH AND LANDING SYSTEMS

The Microwave Landing Systems (MLS) will replace the Instrument Landing System (ILS) as the standard aid for precision approaches. Area navigation is expected to be in widespread use. The use of electronic approach plates is also expected to increase. Category III approach capability will exist in aircraft flying in Canadian airspace although only a few airports are expected to require Category III ground installations.

Table 2.1 AIRBORNE EQUIPMENT UTILIZATION

	1985	1990	2000
NAVIGATION			
VOR/DME	W	W	W
SATELLITE NAV.	--	L	I
DME	W	W	W
INS	L	I	I
LORAN-C	L	L	L
OMEGA/VLF	L	L	D
DOPPLER NAV.	L	D	D
NDB	W	W	W
RNAV.	L	I	I
4D NAV.	--	L	I
COMMUNICATIONS			
VHF COM.	W	W	W
UHF COM.	L	L	L
HF COM.	L	L	L
MODE S (TRANSPONDER ONLY)	--	L	I
MODE S (WITH DATA LINK)	--	--	L
VHF DATA LINK	--	L	L
SATELLITE	--	L	I
VHF WX DATA BROADCAST (VOR)	L	L	L
HF DATA LINK	--	L	L
AIRCRAFT SEPARATION			
TCAS	--	L	L
COCKPIT DISPLAY OF TRAFFIC INFORMATION	--	--	L
SSR TRANSPONDER	W	W	W
SSR MODE S TRANSPONDER	--	L	I
APPROACH & LANDING			
MLS	--	L	I
ILS	W	W	D
ADF	W	W	W
VOR	W	W	W
RNAV.	--	L	I
CAT III	--	--	L

LEGEND L = LIMITED USE W = WIDESPREAD USE
I = INCREASING USE D = DECREASING USE

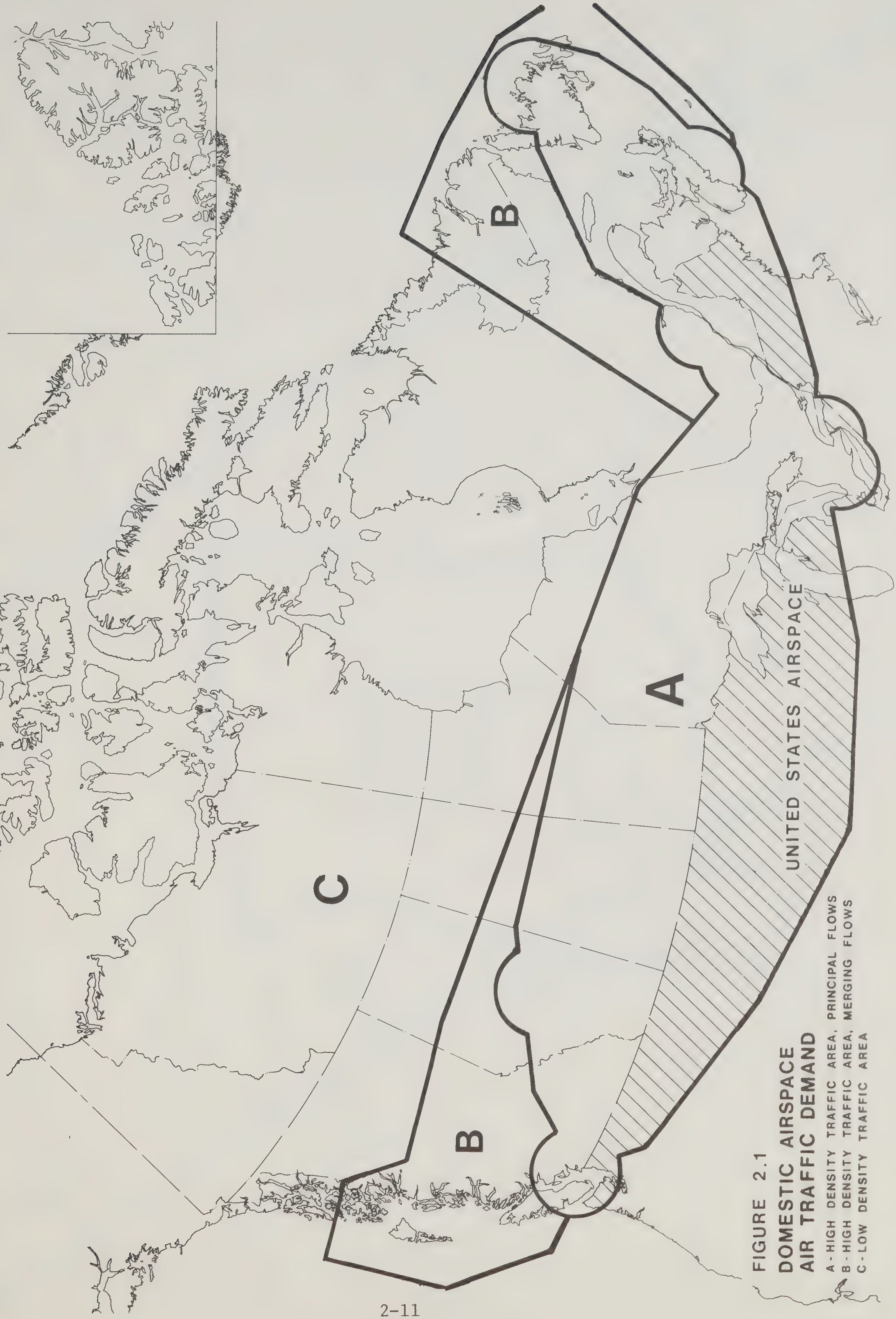


FIGURE 2.1

DOMESTIC AIRSPACE
AIR TRAFFIC DEMAND

A - HIGH DENSITY TRAFFIC AREA, PRINCIPAL FLOWS
B - HIGH DENSITY TRAFFIC AREA, MERGING FLOWS
C - LOW DENSITY TRAFFIC AREA

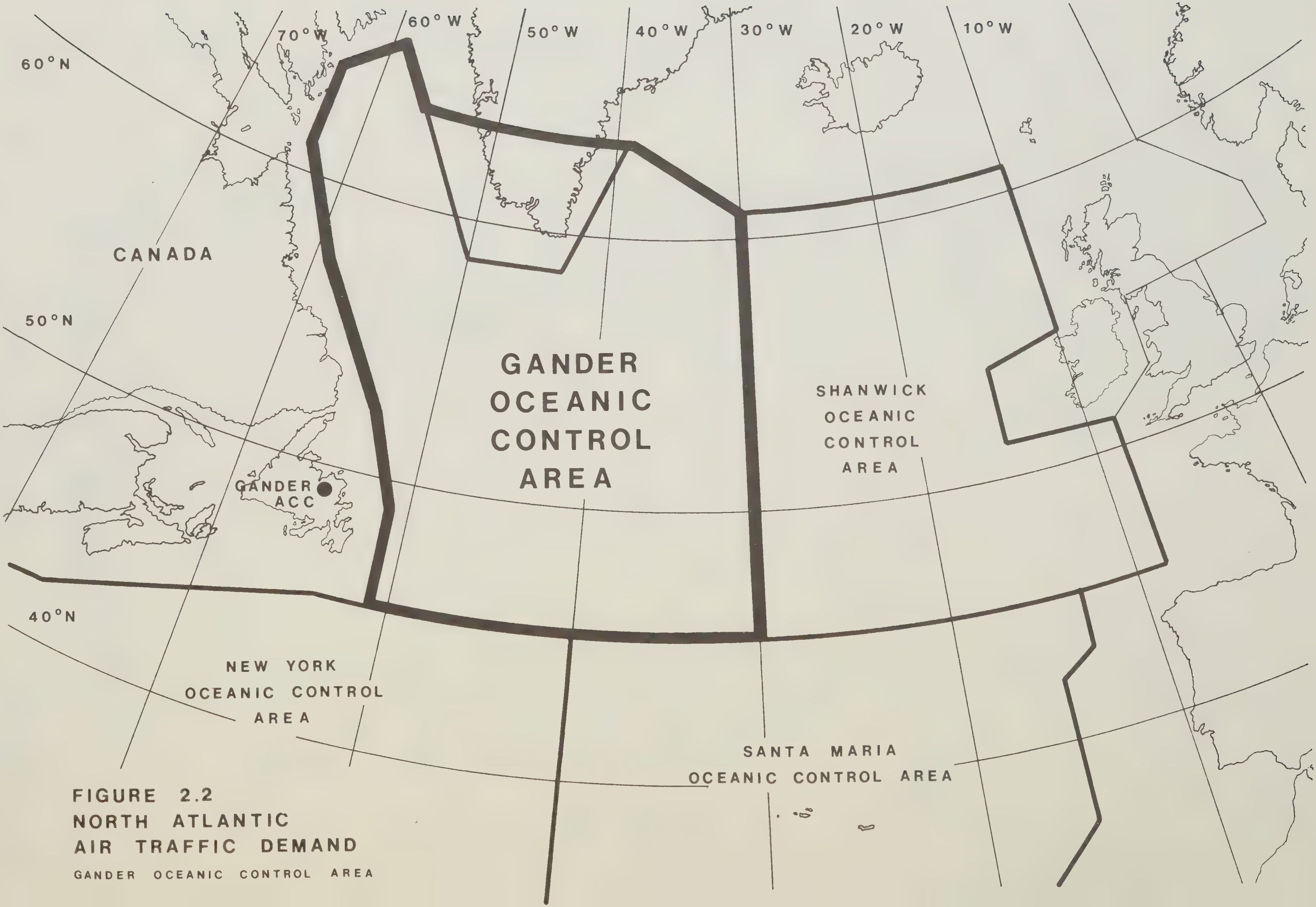


FIGURE 2.2
NORTH ATLANTIC
AIR TRAFFIC DEMAND
GANDER OCEANIC CONTROL AREA

CHAPTER 3

AIR TRAFFIC SERVICES

CHAPTER 3 AIR TRAFFIC SERVICES SYSTEM

CONTENTS

ILLUSTRATIONS

CHAPTER 3 AIR TRAFFIC SERVICES SYSTEM

3.1 GENERAL

Canada's Air Traffic Services organization is functionally responsible for providing air traffic control (ATC) and advisory services in the airspace overlying Canada and in international airspace for a major portion of the North Atlantic. Covering an area of about 5.8 million square miles, Canada's ATC responsibilities are second only to that of the United States.

Operated from Area Control Centers (ACCs), Terminal Control Units (TCUs) and Control Towers (TWRs) the ATC System forms an integral part of Canada's National Airspace System. From TWRs controllers provide ATC services on the airport and in the airspace in its immediate vicinity (Airport Control Zones). ATC services provided from TCUs apply within Terminal Control Areas which are larger volumes of airspace and include one or more airports. ACCs are responsible for providing ATC services in an entire Flight Information Region (FIR), of which Canada has 7 domestic and 1 oceanic FIR.

ATC services in Canada are provided in various types of airspace classified in accordance with specific flight rules and procedures; details are contained in the Designated Airspace Handbook (TP 1820). However, for the purpose of developing the ATC systems plan, traffic density-related areas, described in Chapter 2 (Figures 2.5 and 2.6), reflect the distribution of demand for air traffic services.

All air traffic operations in Canada are carried out in accordance with one of two basic rules and variations thereof:

- Instrument Flight Rules (IFR).

- Visual Flight Rules (VFR).

For flights operating under IFR within controlled airspace, the responsibility for ensuring safe separation from all other IFR flights rests with ATC and the separation minima used are commensurate with the surveillance and navigation capabilities pertaining to the particular airspace. For flights operating under VFR, pilots are responsible for their own separation and operate on a "see-and-be-seen" basis.

The ATC system, which is a composite of interdependent subsystems, is used in conjunction with rules and procedures to control air traffic. It is a centralized ground-based management system but the responsibility for the navigation of aircraft remains with the pilot. Most aircraft are navigated by reference to a system of ground-based radio navigation aids, strategically distributed to delineate the airway/air route structure.

Generically, ATC sub-systems are categorized according to the following functions:

- Flight Data Processing — the means by which flight plans (aircraft intentions) are acquired, processed, displayed and distributed in order to provide controllers with a strategic overview of the projected air traffic situation.

- Surveillance — the means by which the actual or real time (continuously updated and generally sensor-derived) air traffic situation is determined and displayed. Within the high density traffic area, where reliance on tactical control is necessary for safe and efficient air traffic operations, surveillance is, and will be in the foreseeable future, effected through radar data processing systems.

- Communications (air-ground and ground-ground) — the means by which voice and data communications are achieved between controllers and pilots and with flight service specialists.

- Aeronautical Information Processing — the means by which information on environmental conditions such as wind direction and speed, weather, visibility, temperature, and other aviation related conditions such as serviceability of navigation aids and runway status are acquired and displayed to assist in the provision of advisory services to users.

The ATC service provided by TWRs, of which Transport Canada operates 61, is primarily based on visual detection and control. At busier airports, radar data displays are used to monitor air traffic operating in the vicinity of the airport. At Toronto, Vancouver and Mirabel, Airport Surface Detection Equipment (ASDE) enables controllers, during conditions of reduced visibility, to monitor the position of aircraft and vehicles on the manoeuvring area of the airport. At some TWRs, Very High Frequency Direction Finder (VHF-DF) equipment enables controllers to provide pilots operating in a non radar environment with direction information.

There are 15 TCUs in Canada's ATC system, 7 of which are co-located (integrated) with the ACCs at Gander, Moncton, Montreal, Toronto, Winnipeg, Edmonton and Vancouver. The other TCUs are situated at Halifax, Quebec City, Ottawa, North Bay, Thunder Bay, Regina, Saskatoon and Calgary.

There are also 9 Military Traffic Control Areas (MTCAs) located at Greenwood, Bagotville, Chatham, Trenton, Portage La Prairie, Moose Jaw, Cold Lake, Comox and Goose Bay.

A TCU is primarily responsible for providing ATC services within Terminal Control Areas (TCAs) to all arriving, departing and transiting IFR flights. TCAs vary in size depending on the volume and complexity of air traffic operations. Within this airspace control is principally effected by the use of radar surveillance. At the busier locations, such as at Toronto, Montreal and Vancouver, the TCUs also provide advisory services to VFR flights. TCUs are typically organized into a number of workstations; usually each workstation is operated by one controller and covers control functions such as arrival, departure and coordination.

3.1 GENERAL Cont'd

At present, different types of systems and equipment are provided at TCUs. Those TCUs located within the ACCs are equipped with recently installed computer-based systems. These systems are the same as those used in the ACCs and are described later. At the stand-alone TCUs no computer based systems are used. At these facilities the equipment used to present the air traffic situation consists of:

- Primary Surveillance Radar (PSR) and a colocated Secondary Surveillance Radar (SSR) -- the sensors which provide the radar surveillance capability.

- Radar data displays -- scan-converted TV displays and analog plan position indicators.

- Flight data strips -- manually produced, containing information on the identity of the flight, its intended route and altitude, and other related information.

- Communications (air-ground and ground-ground) — consists of radio telephony and telephone links. Teletype circuits link TCUs with the aeronautical fixed telecommunications network (linking all ATS facilities).

- Operational information — including weather data, NOTAMs, etc., generally handwritten and displayed on slips of paper, or boards.

ACCs are responsible for providing control, advisory and alerting services within its FIR. The ACC at Gander has additional responsibility for its Oceanic FIR. The main function of an ACC is to control and monitor the route and altitude of all IFR aircraft while enroute between airports. An ACCs geographic area is usually divided into several sectors with a team of controllers responsible for each sector. The type of surveillance system provided at the control sector (workstation) is based on factors such as air traffic density, safety and operating efficiency. In the High Density Traffic Area, radar systems are the principal means of providing surveillance and permit the use of lower separation minima (spacing between aircraft). In the low density traffic area or oceanic area where the use of radar systems is not possible nor economically justified, surveillance of air traffic is achieved by reference to aircraft (pilot) position reports. In this airspace considerably greater spacing between aircraft has to be used to ensure a safe operation.

At the ACCs with colocated TCUs, equipment used to present the air traffic situation consists of:

- PSR and SSR systems -- the sensors which provide the radar surveillance capability.

3.1 GENERAL Cont'd

- Radar Data Processing System (RDPS) — the system which processes and displays the radar data. At present the Joint Enroute Terminal System (JETS) provides this capability at all ACC's and colocated TCU's.

- Flight Data Processing System (FDPS) — at present the system produces flight data strips and transfers flight plan data to JETS.

- Operational Information Display System (OIDS) — the system which provides controllers with real-time data such as wind direction and speed, temperature, barometric pressure and visibility for major airports. It also provides weather sequences, NOTAMs and other related aeronautical data, for retrieval by the controller.

- Integrated Communications Control System (ICCS) -- the versatile computer based system for controlling (switching) intra- and inter- facility voice communications.

- Voice communications -- the ground-to-air VHF radio telephony, and ground-to-ground telephone (voice) links.

- Automated Data Interchange System (ADIS) — the domestic portion of the Aeronautical Fixed Telecommunications Network (AFTN) which enables transfer of data between ATS facilities.

The equipment at Gander ACC, to support domestic ATC requirements, is the same as at the other ACC's. However, for oceanic ATC, there is a more advanced flight data processing system, the Gander Automated Air Traffic System (GAATS). Features of this system include:

- Prediction of air traffic conflictions (and warning messages).
- Printing of flight strips.
- Automated data interchange with the oceanic centre in Prestwick, Scotland.
- Statistical data gathering on oceanic operations.
- Automated flight plan transfer to the Joint Enroute Terminal System.
- Automated generation of data on the Organized Track System, (OTS) for input to the Aeronautical Fixed Telecommunications Network.
- A weather model which enables the calculation of flight times and minimum time tracks.

Equipment and systems currently being used for ATC vary from modern to that acquired some 25 years ago. The older equipment, particularly the radar systems and displays, are no longer able to meet operational requirements. In addition to problems of reliability and availability the systems are also very expensive and difficult to maintain and adversely limit the extent to which productivity improvements can be made. Some equipment-related problems are:

3.1 GENERAL Cont'd

- The lack of standardization of controller workstation equipment (except in the ACCs).

- Virtually no systems integration, consequently, ATC data has repeatably to be input making the system unnecessarily labour-intensive.

- Inadequate on-site simulation capability for controller training and proficiency evaluation.

- Obsolete computers with limited capacity.

- The absence of a real time on-line Flight Data Processing System for the automated acquisition, processing, display and transfer of air traffic information.

These equipment-related limitations as well as the systems' inability to handle data from the new Radar Modernization Project (RAMP) radars will need to be resolved in order to realize the extensive benefits and reduction in operating costs, that automation offers. Also, most functions, such as conflict checking, issuing of ATC clearances and advisories, and transfer of control of an aircraft from one controller to another still involve manual actions, adding to the workload.

Systems for controller training are also in need of urgent improvement. Recent studies have shown that the cost per successful trainee is inordinately high. More effective training systems, capable of accurately simulating the ATC environment, have been identified as a means of reducing controller training costs. Existing training systems at the Regional schools are not adequate.

The study of ATC problems such as operating procedures and human factors, is carried out at the ATS Research and Experimentation Centre. The use of this facility has enabled the safe introduction of proven cost effective operating practices. To meet the demands of the future considerable upgrading of the facility will be required.

3.2 THE NEW APPROACH

The future ATC system will gradually evolve from being dependent on tactical control, which is inherently labour-intensive, to a more strategically managed and efficient control system. The future ATC system will still be sensitive to airport acceptance capacities but, close to "no delay" operations will be attained from a more effective Flow Management System. This is achievable by the availability of real time flight demand data provided by the interlinked flight data processing systems.

The enhanced surveillance (radar) coverage and air-ground data transfer through Mode S, together with improved controller workstations and upgraded interfacility communications, will

enable air traffic operating in the high density traffic area to fly the most fuel-efficient flight profiles. In the low density traffic area and oceanic area, air-ground data transfer via HF or satellite will also provide for more efficient aircraft operation. Based on this real time acquisition and processing of aircraft data, the ATC system will be upgraded to provide the controller with computer-calculated conflict prediction and conflict resolution information.

The objectives of modernizing the ATC system are to maintain a very high level of safety, impose minimum constraints consistent with efficient use of the system, increase controller productivity and minimize operating costs. This involves the replacement of obsolete equipment and the extended use of automation leading to the establishment of a fully integrated ATC system.

Towards meeting the need for eventual integration of the ATC System, a Major Crown Project, the Flight Data Systems Modernization Project (FDMP) has been established to incorporate all flight data processing and associated activities, including the functions of the Gander Automated Air Traffic System. Initially, emphasis will be placed on improving data distribution and reducing labour-intensive operations. To accomplish this, a meteorological model for calculating fix times, sector printers, and automatic intersystems and interfacility data transfer will be implemented. Eventually, electronic data displays will replace paper flight strips and new functions will be added to provide aircraft with computer generated conflict free, fuel-efficient flight profiles. Additionally, functions to assist the controller, such as conflict prediction and conflict resolution alternatives, will be included in the Flight Data Processing System.

The existing National Flight Data Processing System (NFDPS) will require interim enhancements including data links between ACCs, TCUs, TWRs and the RAMP radar data processing systems. Further sector strip printers will be provided in ACCs as well as remote site printers in TCUs and TWRs.

To meet internationally identified oceanic ATC requirements, some enhancements will also be made to the Gander Automated Air Traffic System (GAATS). These include improvements to the data-link with Prestwick, Scotland, the U.S. National Weather Service and a link to the Moncton Area Control Centre. The conflict prediction algorithm will be modified to meet IACO Separation Standards.

The future Radar Data Processing System (RDPS) will evolve from the present Joint En-route Terminal System (JETS) and will be implemented through the Radar Modernization Project (RAMP) and the subsequent Mode S data link upgrade. The RDPS will continue to use the distributed processing configuration of the existing Joint Enroute Terminal System and will be designed to provide virtually 100% availability and reliability. Several new functions will be added to the Radar Data Processing System to provide a comprehensive display of radar derived data including:

- Display of hazardous weather.
- Multi-tracked or mosaicked radar data.
- Conflict alerting.
- Hazardous airspace warning.
- Mode S data link and information display.
- Radar data recording and play-back.
- Statistics recording and analyses.

The SSR Mode S is a combined secondary surveillance radar and air-ground data link system capable of providing improved aircraft surveillance data and communications necessary to support ATC automation in the increased traffic density environments expected in the future. It will be compatible with current SSR transponders (avionics) and thus implementable at low user cost over an extended transition period.

The new Communications Control System known as the Modular Aeronautical Communications Switch (MACS) will be implemented at all ATS facilities other than ACCs; the latter facilities use the Integrated Communication Control System (ICCS).

In addition to reducing operating costs, the new system will provide more efficient and flexible intrafacility communications. Existing communications equipment in TWR's, FSS's and stand-alone TCU's will be replaced with the new Communications Control Systems.

The existing ICCS meets the projected operational requirements for ACCs. Its useful life will be extended to the year 2005 by upgrading its central processor and other related equipment. This upgrading will be implemented by the end of 1991.

The function of aeronautical information processing, currently provided on a limited basis by the Operational Information Display System (OIDS), will be enhanced and expanded to serve as a regional data base. This will be accessible by all ATS facilities and workstations. While such a system will be capable of meeting most needs, there will continue to be a requirement for local (at the airport) real time data such as instantaneous reading of wind speed and direction, runway visual range and the status of approach and landing aids. These requirements will be met through scaled down versions of today's Operational Information Display System. Other non real time, critical aeronautical information will be centralized in the regional data base. Aircraft equipped with air-ground data link will also be able to access data directly from the regional Aeronautical Information data base.

Functions such as Flight Data Processing, Aviation Weather Processing and Aeronautical Information Processing will be carried out at each Area Control Centre and will serve an entire Flight Information Region. These systems will be interlinked and accessible by the users (airlines and aircraft operators).

3.2 THE NEW APPROACH Cont'd

As a part in realizing the extensive benefits of automation and total systems integration, a versatile controller workstation built around air traffic situation displays will be developed. The main display (geographical format), similar to present-day plan view radar displays, will depict annotated (tagged) real time data derived from multi-radar sensors or aircraft positional data obtained via air-ground data link. At some workstations, data derived from both sources will be integrated and displayed. Complementing the geographical display will be a tabular display of flight data. These displays, combined in a controller workstation, are the long term replacement for data now displayed on paper flight strips and the plan view displays. The displays will be interchangeable and capable of automatic back-up in the event of failure. Additional supplementary displays for ATC planning and probing, and for displaying aviation related information will complete the workstation. Considerable human engineering will be required in developing and introducing these highly automated controller workstations.

To reduce the chances of total system failure, each controller workstation will be capable of operating autonomously. Using distributed processing (minicomputers/microprocessors at each workstation) the capability will be provided for maintaining limited data bases and for supporting several ATC functions. To the maximum extent practicable workstations in TWR's and FSS's will have equipment common to that of enroute and terminal facilities.

The deployment of ground-independent airborne separation assurance systems such as the ACAS (Airborne Collision Avoidance System), will introduce a further level of overall system redundancy. Airborne Collision Avoidance Systems are a significant feature of the FAA's National Airspace System Plan and the timing of its use in Canadian airspace will depend on experience gained in the United States and in its acceptance by users.

In summary, the modernization plans are designed to replace the current ATC systems, and to develop new systems in conformance with meeting the future needs for improved safety and productivity, greater capacity and reliability. Against a projected doubling in traffic growth by the year 2000, modernization of the ATC system, principally through the comprehensive use of automation, will ensure virtually no growth in the number of air traffic controllers compared with the present strength but will result in a significant increase in productivity.

Admittedly, the cost of modernizing the ATC system will be great, but the impact of not doing so will result in substantially higher operating costs, critical failures of system components (which would adversely impact safety), reduced controller productivity, and costly delays to users.

3.3 EVOLUTION OF THE SYSTEM

CURRENT PROGRESS (TO 1985)

During this period, activity concentrated on modifying to the extent economically and technically practicable existing ATC computer-based systems to increase their capability and capacity. In addition, activities were undertaken to reduce duplicated manual data entry and to incorporate labour-saving enhancements such as intersystem links. Although improvements to systems and equipment in ACCs and colocated TCUs were carried out, no similar improvements were planned, during this period, to existing equipment in TWRs and stand alone TCUs.

As a stop gap measure, to overcome critical problems in radar data processing caused by the present limited capacity of the JETS, memory expansion of the system's central computer complex and display processors was implemented. In parallel, replacement of the central computers with new hardware was initiated under the Radar Modernization Project (RAMP). The design specification for the new hardware provides for additional computing capacity to process surveillance and weather data from the new RAMP radar systems.

To eliminate the dual entry of flight plan data, which creates operating efficiencies, the present National Flight Data Processing System (NFDPS) and the present radar data processing data system (JETS) were interlinked. Similarly the JETS and the GAATS were interlinked. Additonally, more efficient software was incorporated into the GAATS, thereby increasing its capacity. Other operational improvements to the GAATS included enhanced data integrity on the trans-oceanic link to Prestwick, Scotland, additional user-terminals, updates to conflict prediction to meet IACO separation minima and changes to flight strip formats to improve operational efficiency. A preliminary evaluation of air-ground data transfer, using the VHF ACARS (ARINC Communications and Reporting System) in conjunction with an Air Canada Boeing 767 aircraft, was undertaken. Programming action was initiated to provide an OIDS-type capability at stand alone TCUs through a system known as the Terminal Information Processing System (TIPS).

Studies are being carried out for establishing a system to handle flow management and airspace reservation requirements. Such a system has potential for reducing existing manual methods of coordination with the Department of National Defence and with the Federal Aviation Administration (FAA). The FAA has loaned a terminal which connects with their Central Airspace Reservation Facility (CARF) for a two year evaluation starting in early 1986.

Human factors studies and related engineering development have been started, which will lead to the operational and technical specification of the future common controller workstation. These activities include continuing development of the weather display system, replacement of flight data strips with elect-

3.3 EVOLUTION OF THE SYSTEM

CURRENT PROGRESS (TO 1985) Cont'd

ronic tabular displays and use of dependent surveillance supported by air-ground data link in ATC operations.

Studies were initiated for replacing the ATS Research and Experimentation Centre systems. Implementation is scheduled for the early 1990's.

Similar activities were undertaken for replacement of the ATC training systems at TCTI and for on-site controller training and proficiency evaluation systems. To the maximum extent practicable these systems will be built around the use of common displays, functions, hardware and software.

NEAR TERM (TO 1990)

Many important system changes will be made during this period. Most changes will result from incorporating the RAMP radars and by upgrading and enhancing the radar and flight data processing systems.

With introduction of the new RAMP radar and display systems, the display of surveillance information to the controller will be improved. At all major ATC facilities, tracked and (where required) mosaicked PSR and SSR data along with hazardous weather information will be displayed in graphical format to controllers. Outdated display equipment in 19 TWRs and 8 standalone TCUs will be replaced with the new computer based digital display systems. Radar data recording and playback will be provided. The capability for limited on-site controller training and proficiency evaluation will be provided with the new RAMP display systems. Conflict Alert and Hazardous Airspace Warning functions will be added.

The existing NFDPS at each ACC will be upgraded to provide data interchange with other systems and ATS units. The provision of strip printers at the ACC sectors and at some remote ATS units will be completed.

Until implementation of the new flight data processing system under FDMP some additional functional enhancements of the GAATS will be implemented to meet Oceanic Control requirements. Improved data transfer with Prestwick, Scotland will be implemented for compatibility with the new CAA system. Data transfer from the US National Weather Service and a data link to the Moncton ACC will be completed.

The Operational Information Display System (OIDS), in place at the ACCs will have its computer capacity increased in early 1986 to enable access to additional support data. In the same time frame a computer-to-computer link with the JETS will provide automatic update of altimeter information, thus eliminating another manual input.

3.3 EVOLUTION OF THE SYSTEM

NEAR TERM (TO 1990) Cont'd

A detailed analysis of requirements and programming will be undertaken for an Aeronautical Information Processing System to replace the existing OIDS. When linked by CADIN it will be possible for all ATS facilities and users to access such a data base. Similar activity (and capabilities) will occur in the deployment of an Aviation Weather Processing System. It is intended to enhance the present alpha-numeric presentation of weather data by developing an easily interpretable graphic format depicting vertical and horizontal cross sections along flight plan routes as well as point and area forecasts.

Procurement of new equipment and software for upgrading ICCS will be in progress. The retrofit should be completed by the end of 1991.

The initial deployment of the new MACS at all TWRs and stand alone TCUs will be completed. These systems will provide increased operating flexibility, increased reliability, and will be capable of supporting intrafacility voice and data communications.

Expansion and upgrading of the systems hardware and software at the Research an Experimentation Centre will begin. Replacement of the training simulator at TCTI will be started. At the regional and facility level the initial training simulators will be implemented. These systems are a part of the overall program to provide realistic training systems which are capable of being upgraded to reflect actual ATC operations.

Specifications for the Flow Management System will be developed. This system, by matching air traffic demand with airport and terminal control area capacities at selected locations, will provide advance information on where delays are likely to occur and propose alternatives for minimizing them.

The installation of six new solid-state ASDE radars will be completed by 1989.

LONG TERM (TO 2000)

The major activity during this period will be integrating the capabilities of the several computer based systems into the Advanced Integrated ATC System. By the year 2000, due to the extensive use of automation, the ATC system will be safer, more reliable, more efficient and will contribute to an almost doubling in controller productivity.

3.3 EVOLUTION OF THE SYSTEM

LONG TERM (TO 2000) Cont'd

The introduction of the common controller workstation will allow considerable flexibility in ATC sectorization and management of the airspace under a controller's jurisdiction. The scope of the technical framework of the plan will offer several alternatives for operational exploitation and personnel utilization. Functions which are necessary for such operation will be implemented.

Under the auspices of the Flight Data Systems Modernization Project (FDMP) the flight data processing system will maximize the automation of clerical functions currently performed by ATS personnel. It will operate on-line and in real time with all ATS units, air carriers, DND and other states.

The Flight Data Processing system will be designed to include the new capabilities of conflict prediction and resolution, hazardous airspace warning, flow management options and metering and sequencing in terminal control areas. Features critical to maintaining a minimum safe level of air traffic control service will be implemented at the new common controller workstation where flight strips will be replaced by electronic displays. Local area networks will interlink all workstations and the central computer complexes.

A second phase of MACS will complete the replacement of obsolete communications control systems by 1994.

The SSR system will be upgraded to Mode S. This mode permits the discrete addressing of aircraft and communications via air-ground data link. It will also provide improved surveillance information and enable the automatic transfer of information between aircraft and ATC systems. In the low density traffic area, where Mode S coverage is not available, HF or Satellite air-ground data link will provide similar capabilities.

Towards the end of the period comprehensive flow management will become operational. Initially, controllers will be provided with advisories on traffic congestion delays, but eventually the system will be on-line with the regional Flight Data Processing Systems. The system will provide automatic determination of alternative clearances to minimize costly fuel delays.

The replacement of simulators at the R and E centre, TCTI and Regional ATS facilities will be completed.

FIGURE 3.1. (a) AIR TRAFFIC SERVICES SYSTEM EVOLUTION

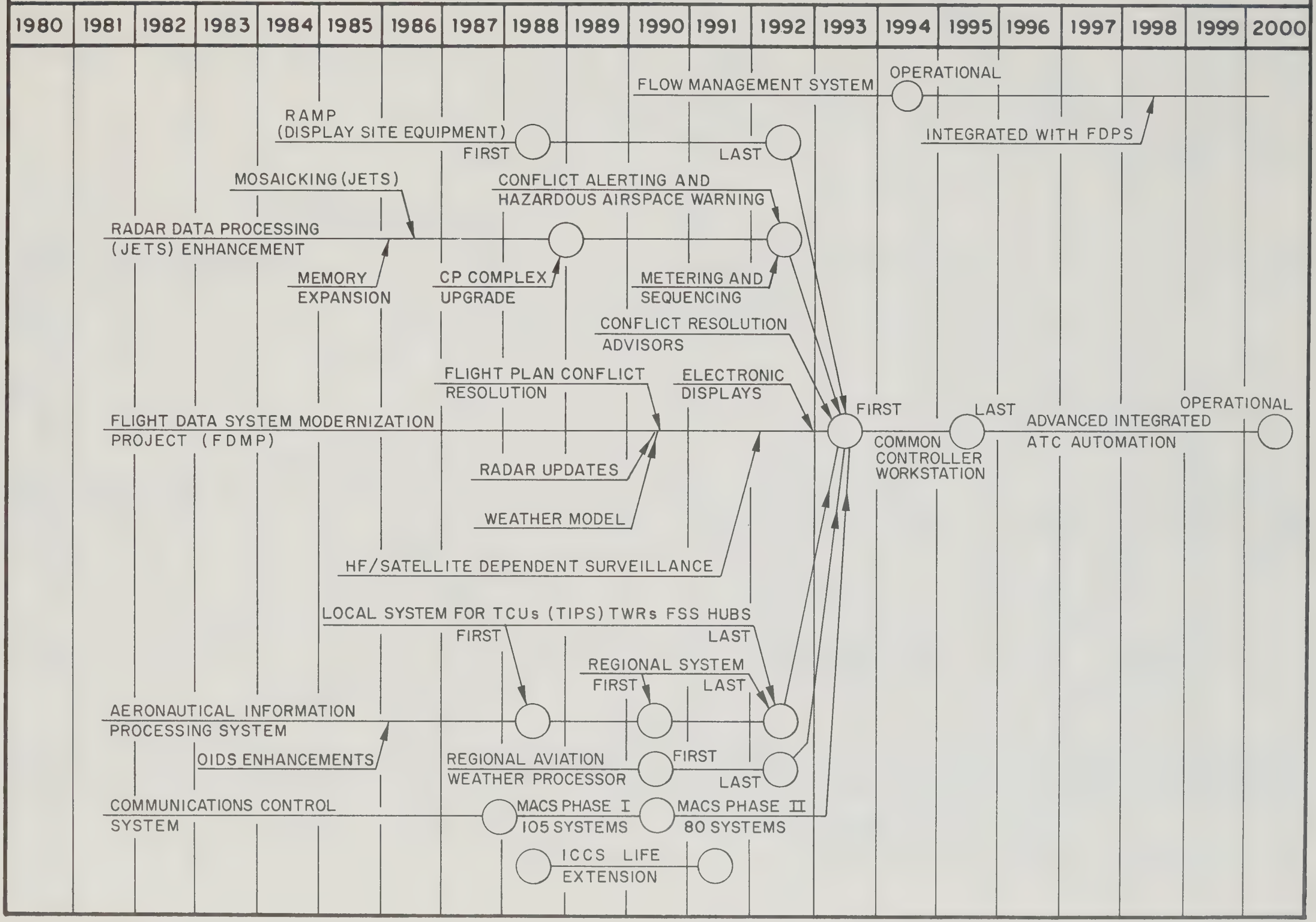


FIGURE 3.1.(b) AIR TRAFFIC SERVICES SYSTEM EVOLUTION

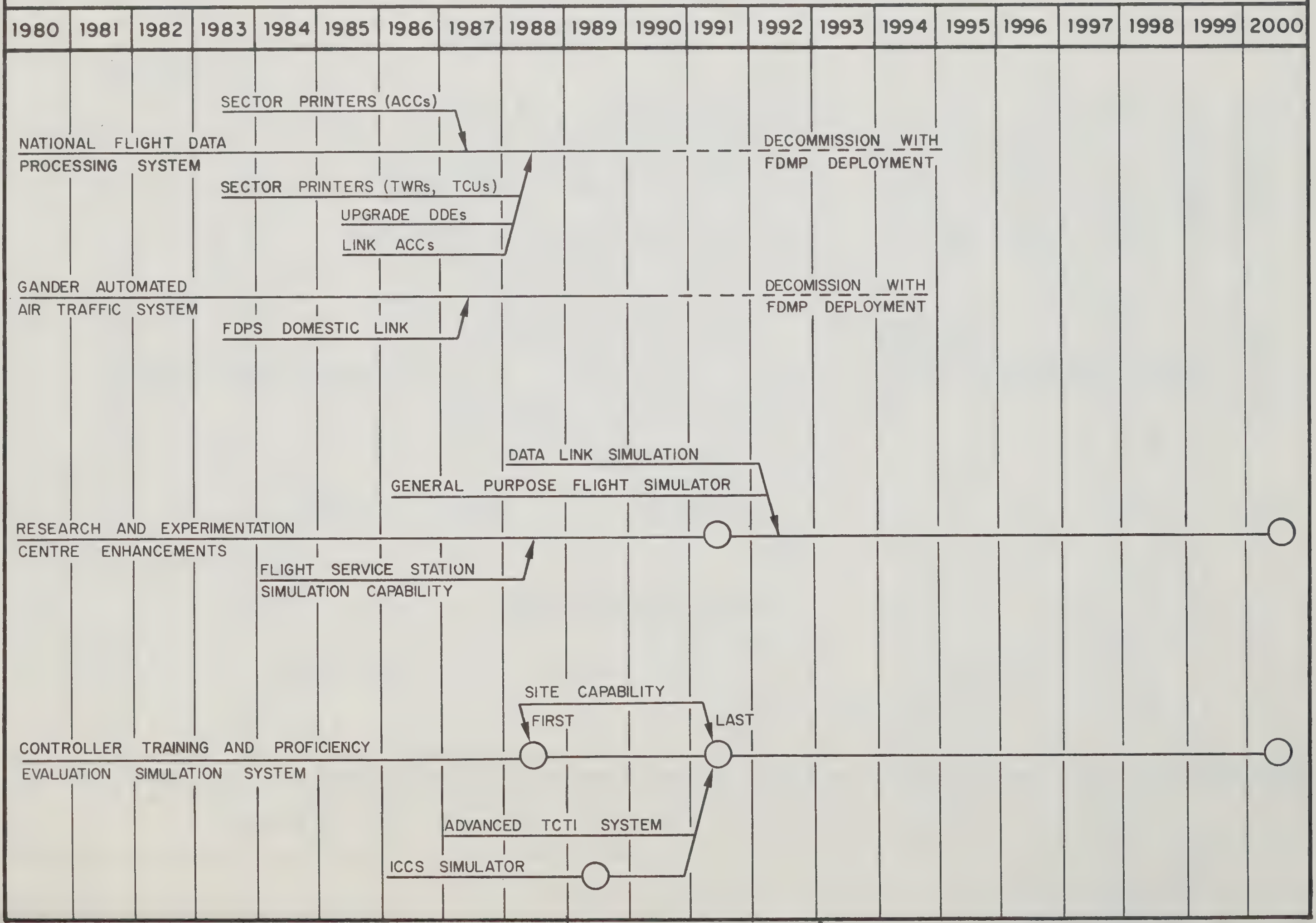


Fig. 3.2.

1985: ATC FACILITIES

ACC □
TCU △
TOWER ●

3.4 BENEFITS OF THE PLAN

Expanding the use of automation will result in an upgraded ATC system and will serve as the basis for significant improvements in air safety. In the foreseeable future, those routine and repetitive tasks which add to the controller's workload and which limit his traffic management capacity will be systematically transferred to automated systems. This process will take several years to accomplish. By increasing controller productivity through the use of automation it will be possible to accommodate the increase in air traffic demand without a corresponding increase in the number of controllers. By exploiting the potential of automation and through systems integration, considerably greater reliability and flexibility will be realized. The most important benefit of the measures described in this plan, in terms of the controller's work environment, will be in providing a considerably higher level of job satisfaction.

Personnel requirements and operations and maintenance costs are not expected to increase significantly over the period of this plan (to the year 2000). If the implementation of the plan proceeds on schedule it is expected that personnel requirements for providing ATC services will level off at about 2800 by the year 2000.

3.5 AIR TRAFFIC SERVICES: PROGRAM OF PROJECTS

PROJECT		IMPLEMENTATION 1st	IMPLEMENTATION Last
1.	Radar Data Processing System (JETS) Enhancements	1983	1989
2.	Gander Automated Air Traffic System (GAATS) Enhancements	1983	1990
3.	National Flight Data Processing System (NFDPS) Enhancements	1983	1990
4.	Flight Data Systems Modernization (FDMP)	1989	1995
5.	Radar Modernization Project (RAMP) Display Site Equipment (DSE) for TCUs and TWRs	1988	1992
6.	Aeronautical Information Processing System (AIPS)	1988	1992
7.	Communications Control System - Modular Aeronautical Communications Switch (MACS)	1987	1994
8.	Life Extension, Integrated Communications Control Systems (ICCS)	1990	1991
9.	Tactical Conflict Alerting and Hazardous Airspace Warning (Radar Sensor Derived).	1990	1992
10.	Common Controller Workstation	1993	1995
11.	Research and Experimentation Centre System Replacement	1989	1995
12.	Controller Training and Proficiency Evaluation Simulation System	1988	1995
13.	Integrated Communications Control System (ICCS) Training Simulator	1989	1990

PROJECT: 1. RADAR DATA PROCESSING SYSTEM (JETS) ENHANCEMENTS

PURPOSE: To increase the capacity of the present systems (JETS) located in the ACC's in order to handle forecast air traffic growth, and to improve processing of data derived from existing radar systems. To upgrade the system in order to meet the expanded data processing demands of the new RAMP radar systems, and to accommodate future enhancements in ATC automation.

Measures have been taken to increase the capacity (computer memory) of the present JETS to meet short term operational requirements. Studies have also shown that the Central Processing Complex will need to be replaced (with new processors) before the RAMP radar systems are implemented. With the change in hardware, the system's software will be written in a High Level Language which will result in a significant reduction in software maintenance effort. The capacity (memory) of the Display Processors has been expanded to handle increased data from the RAMP radar systems.

APPROACH: Initially, the memory of all JETS processors was doubled. Software to provide improved radar data display derived from overlapping radars through mosaicking or multitracking, will be introduced as soon as possible. As part of the Radar Modernization Project (RAMP), JETS is being extensively modified. The current central and tracking processor will be replaced by a multi-microprocessor Radar Data Processor (RDP). Modifications will be made to the display and display processor hardware and software to interface with the local area network used in the upgraded JETS and to display RAMP radar data. All software (with the exception of modifications to the display processor software) is being written in a high level language.

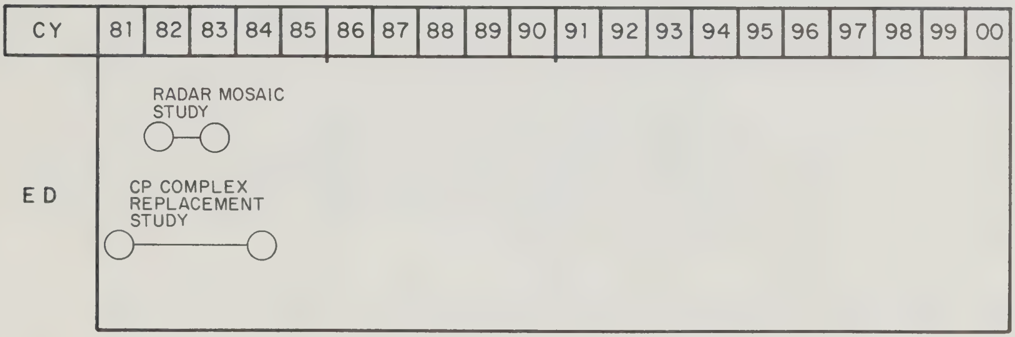
QUANTITIES: All 7 operational JETS plus the (TSC) maintenance and (TCTI) training systems will be upgraded.

RELATED PROJECTS/ACTIVITIES:

- Radar Modernization Project (RAMP)-Display Site Equipment (DSE)
- Radar Modernization Project (RAMP) Radar Site Equipment (RSE)
- Tactical Conflict Alerting/Hazardous Airspace Warning
- Advanced Integrated ATC System
- Research and Experimentation Centre System Enhancements
- Controller Training and Proficiency Evaluation Simulation System/s.
- Common Controller Workstation
- Workstation Ergonomics Studies
- Surveillance Systems Enhancements

RADAR DATA PROCESSING SYSTEM (JETS) ENHANCEMENTS

SCHEDULE



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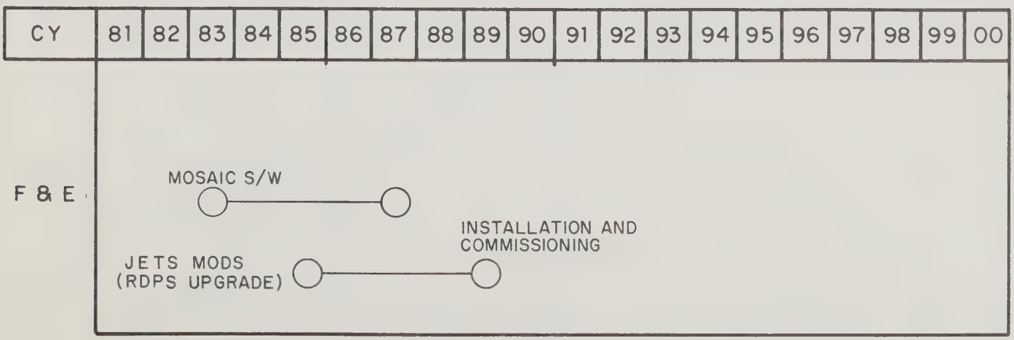


PROJECT: 2. GANDER AUTOMATED AIR TRAFFIC SYSTEM (GAATS) ENHANCEMENTS

PURPOSE: To upgrade the capacity and functional capability of the present system in order to meet operational requirements and internationally identified changes until replaced by the Flight Data Systems Modernization Project (FDMP) system. The present system provides controllers with accurate flight time estimates, air traffic conflict prediction, and minimum time track data. These features enable controllers to assign to aircraft conflict free profiles with some fuel savings. The system is linked to JETS and to the U.S. National Weather Service and automatically exchanges data with the oceanic system in Prestwick.

APPROACH: The present GAATS will see improvements to the data link with Prestwick, Scotland as the new Oceanic FDP system is commissioned in the U.K. Further modifications will be required to upgrade the link with the U.S. National Weather Service. A link will be provided to the new RAMP RDPS and to the Moncton domestic FDP system. Some enhancements will be made to incorporate ICAO changes to separation minima and to address further ICAO commitments as needed.

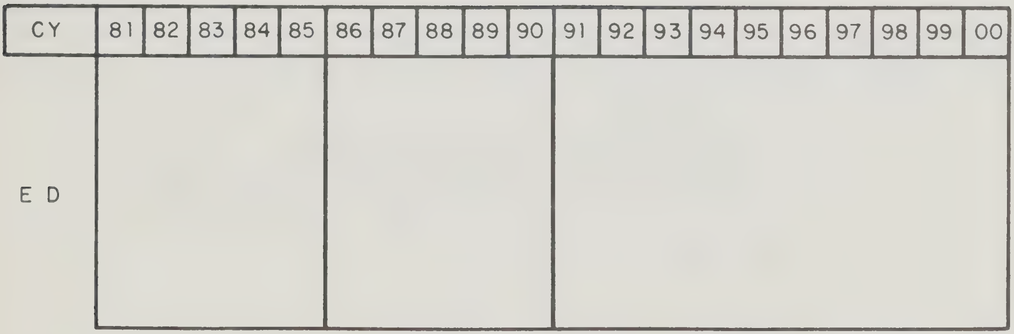
QUANTITIES: Upgrading one system.

RELATED PROJECTS/ACTIVITES:

- National Flight Data Processing System (NFDPS) Enhancements
- Flight Data Systems Modernization Project (FDMP)
- Flight Data Processing Investigations
- Advanced Air/Ground Communication and Data Link Studies
- Automatic Dependent Surveillance Investigations

GAATS ENHANCEMENTS

SCHEDULE



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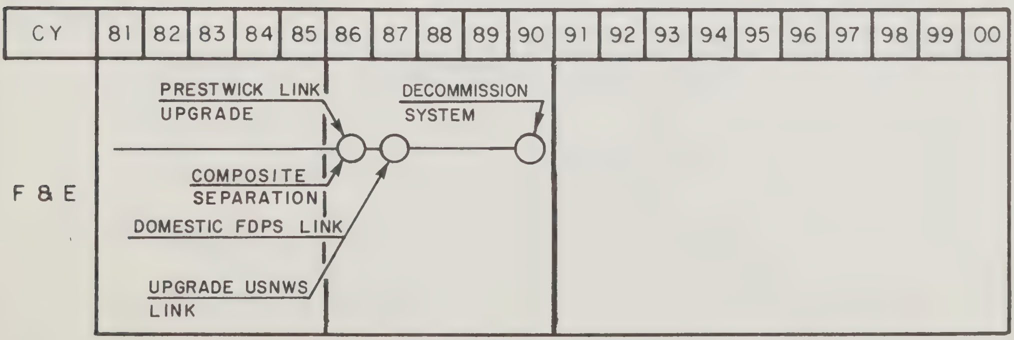


PROJECT: 3. NATIONAL FLIGHT DATA PROCESSING SYSTEM ENHANCEMENTS

PURPOSE: To provide enhancements to the Flight Data Processing System (FDPS) at each Area Control Centre in support of strategic air traffic control operations throughout Canada's domestic airspace.

APPROACH: Enhancements to the existing system will address some short comings by providing FDPS data links to other FDP systems, to RAMP RDPS, remote RAMP DSE's and remote towers (initially to remote printer drops).

Sector printers will be installed in ACCs to improve the timely intra-centre distribution of flight strips.

Display/Data Entry (DDE) equipment will be upgraded to maintain the current level of service.

Enhancements to existing FDPS will be limited in scope as the Flight Data Systems Modernization Project (FDMP) will ultimately replace such systems by the mid 1990s.

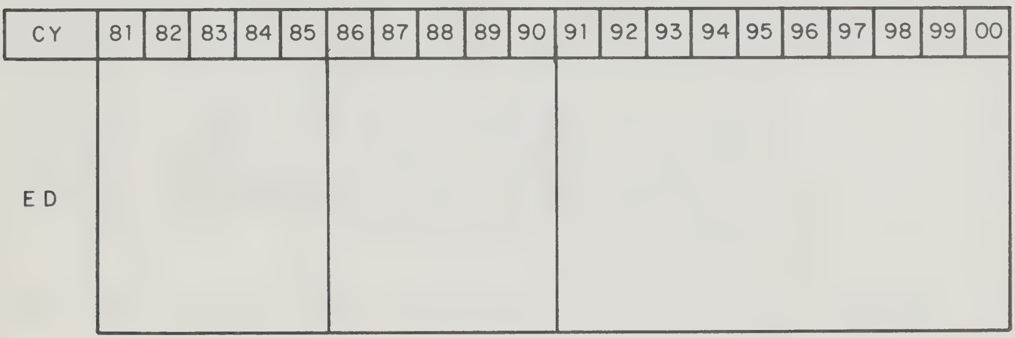
QUANTITIES: Eight systems, one at each domestic ACC, one at the TSC for maintenance (configuration management and control) and one at TCTI for training.

RELATED PROJECTS/ACTIVITIES:

- Gander Automated Air Traffic System.
- Radar Data Processing System. (RDPS)
- Flight Data Systems Modernization Project. (FDMP)

NATIONAL FLIGHT DATA PROCESSING SYSTEM ENHANCEMENTS

SCHEDULE



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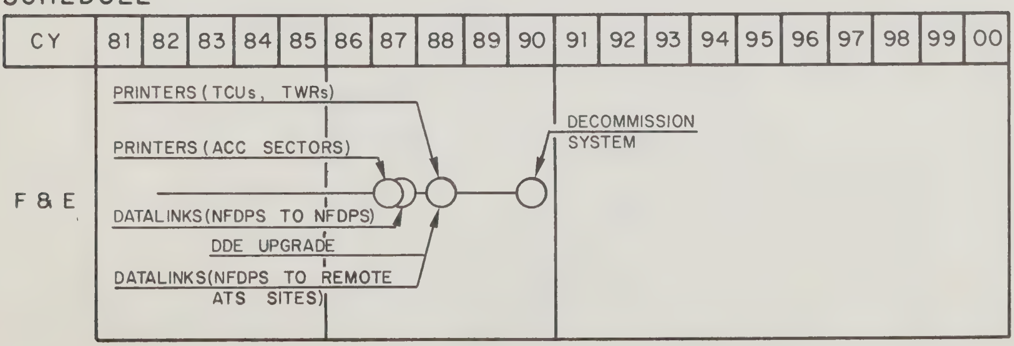

PROJECT: 4. FLIGHT DATA SYSTEMS MODERNIZATION PROJECT (FDMP)

PURPOSE: To provide an advanced automated air traffic system based on the use of state-of-the-art data processing and display technology capable of meeting Canada's needs for air traffic management in both the domestic and oceanic environments. The system will operate on-line and in real time and will incorporate the latest technologies for flight data acquisition, processing and distribution, thus increasing significantly controller productivity and system wide operating efficiency.

The existing flight data processing systems at the ACCs, including the system at Gander ACC, which are labour intensive and uneconomical to operate, will be replaced by the new FDMP system. A prototype of the new integrated controller workstation will be developed.

APPROACH: The design development and implementation of the system will be carried out under the Flight Data Systems Modernization Project (FDMP). The system will consist of a central computing complex, distributed processing at the controller workstation linked via a high capacity local area network. The local area network and the gateway switch at each ACC will provide intra-ACC interconnectivity to other systems and, via a virtual network, will also provide inter-ATS-unit connectivity. The virtual network will also link aircraft operations, DND, AES Weather Systems and ATS systems of other States. Modular expansibility and software generated in an approved high order language will be a design requirement of the system. The system will be phased in over the period 1989 to 1995. Initially, until the Aeronautical Informatin and Weather Processing Systems are made available, the FDMP system will provide access to these data from its own data base (for the purposes of flight planning).

QUANTITIES: Seven systems (one at each ACC) plus systems at TSC, TCTI and the R & E Centre.

RELATED PROJECTS:

- Radar Modernization Project (RDPS)
- Radar Modernization Project (DSE)
- Common Control Workstation
- Controller Training and Proficiency Evaluation Simulation System
- Automatic Dependent Surveillance Investigations
- Canadian Aeronautical Digital Network
- Telecommunication Network Investigations
- Workstation Ergonomics Studies
- Aeronautical Information Systems Studies
- Weather Detection, Processing and Dissemination Systems
- Aeronautical Information Processing System
- Modular Aeronautical Communications Switch

FLIGHT DATA SYSTEMS MODERNIZATION

SCHEDULE

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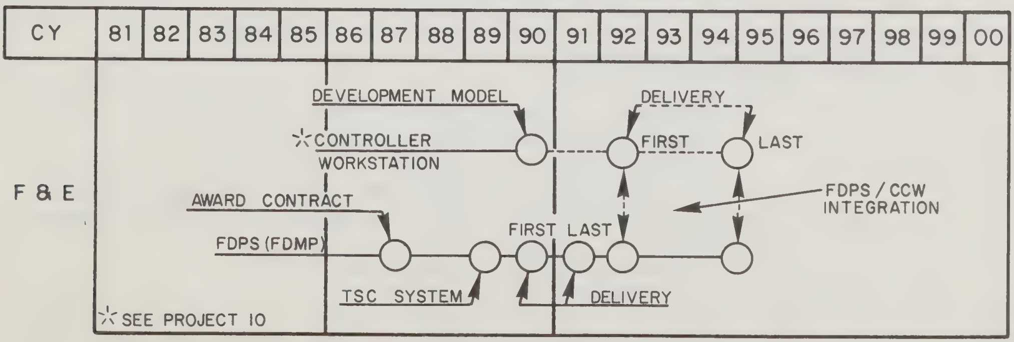
SCHEDULE



PROJECT: 5. RADAR MODERNIZATION PROJECT (RAMP) DISPLAY SITE EQUIPMENT FOR TCUs AND TWRs

PURPOSE: To provide ATC with modern computer based radar processing and display systems for TWR's and stand alone TCU's.

Systems and equipment now in use at stand-alone TCU's and at the busier TWR's consists of outdated plan position indicators and scan-converted (TV-type) displays. The systems are 20 or more years old and are not computer driven. Radar data are displayed in analog format, without aircraft identity tags or altitude information, requiring controllers to mentally maintain the association between the displayed target and its identify. This limits the number of aircraft that a controller can manage.

The new Display Site Equipment will display radar-derived aircraft positions automatically associated with identity, altitude and speed. The system will effect automatic transfer of control of aircraft. other pertinent data will be displayed in digital format thereby enabling normal lighting to be used in the ATC operations environments. Daylight viewing displays displays will be provided in TWR's.

APPROACH: The design, development, testing and installation of these automated systems is part of the Radar Modernization Project. The systems will consist of processor-based display systems communicating via a local area network. Through the use of distributed processing each display unit will be capable of autonomous operation and will provide a highly reliable and available system. Modular expansibility of these display units will be a design requirement as it is planned to use these units to develop the main situation display of the Common Controller Workstation.

To the maximum extent practicable common hardware and software will be provided in TCU's and selected TWR's. The capability for limited on-site controller training and proficiency evaluation will be provided on these systems.

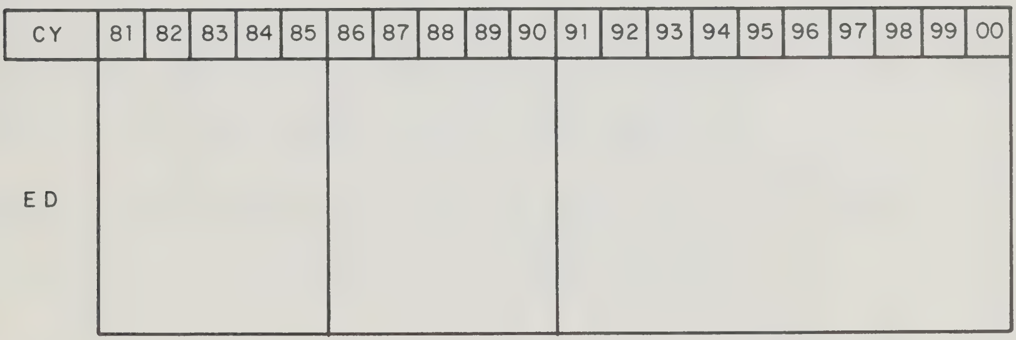
QUANTITIES: Approximately 120 display units will be acquired for the 19 TWR's and 8 stand-alone TCU's plus one system for the TSC and one for TCTI.

RELATED PROJECTS/ACTIVITIES:

- Radar Modernization PROJECT (RAMP) Radar Site Equipment
- Radar Data Processing (JETS) Enhancements
- Common Controller Workstation
- Tactical Conflict Alerting/Hazardous Airspace Warning
- Controller Training and Proficiency Evaluation Simulation System/s.
- Communications Control System.

RAMP (DISPLAY SITE EQUIPMENT) FOR TCUs AND TWRs

SCHEDULE



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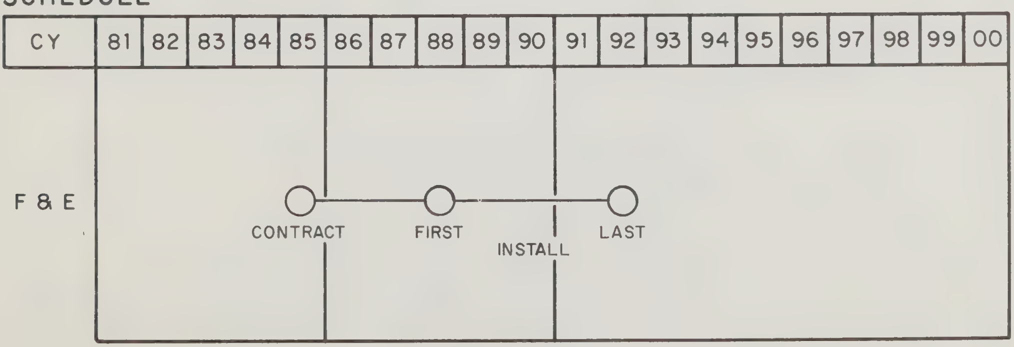


PROJECT: 6. AERONAUTICAL INFORMATION PROCESSING SYSTEM (AIPS)

PURPOSE: To provide essential aeronautical information on a timely basis to all ATS facilities, pilots and aircraft operating agencies.

The provision of accurate and timely aeronautical information is essential to ensure safe and efficient air traffic control. Currently, the Operational Information Display System (OIDS), located in each ACC, provides aeronautical data (both real time sensor-derived and stored) to all controller workstations. The system's capacity is limited and it uses outdated computer technology. Apart from the ACC's and their colocated TCU's and TWR's, no similar capability exists at other ATS facilities. As a part of modernizing the ATS system and improving efficiency, the capability of the Operational Information Display System will be provided at all ATS facilities.

APPROACH: Activity is underway to enhance functions and to increase computer capacity. Action will be initiated to reorientate the development of the Operational Information Display System to reflect the expanded requirement for region-wide on-line access to aeronautical information.

In effect, the new approach, will be to provide all ATS facilities with "local" aeronautical information, including real time sensor derived data such as windspeed and direction, altimeter setting, runway visual range, and status of navigation and approach aids. Other non real time critical data will be stored in the regional Aeronautical Information Processing System at each ACC and will be accessible by all ATS facilities and aircraft operating agencies.

For stand alone TCUs and colocated TWRs an OIDS-type system with a graphics capability (to replace VIP displays) will be deployed to complement the regional OIDS. This system will be referred to as the Terminal Information Processing System (TIPS).

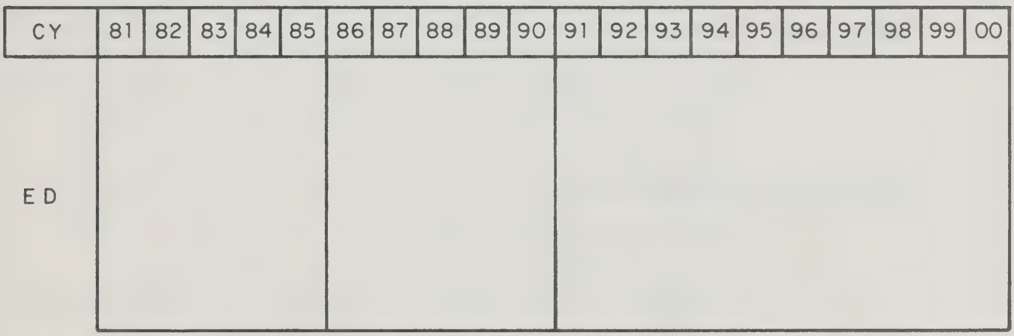
QUANTITIES: 7 Aeronautical Information Processing Systems for the ACC's.
3 Systems for use at the TSC, TCTI and the R&E Centre.
8 Terminal Information Processing Systems.

RELATED PROJECTS/ACTIVITIES:

- NOTAM System Automation
- Canadian Aeronautical Digital Network
- Common Controller Workstation
- Workstation Ergonomics Study
- Flight Information Services Automation
- Aeronautical Information Services Studies
- Flight Data Systems Modernization Project
- Weather Detection, Processing and Dissemination Systems
- Advanced Air/Ground Communications and Data Link Studies

AERONAUTICAL INFORMATION PROCESSING SYSTEM (AIPS)

SCHEDULE



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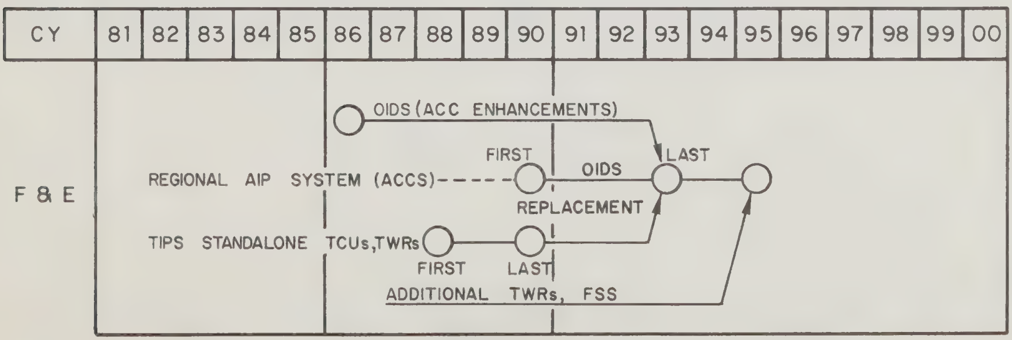


PROJECT: 7. COMMUNICATIONS CONTROL SYSTEM - MODULAR AERONAUTICAL COMMUNICATIONS SWITCH (MACS)

PURPOSE: To provide, at all TCUs, TWRs and FSSs, a modern voice switching and Communications Control System.

This system will provide the intrafacility voice links, as well as the interfacility and ground-air voice communications interface. This system will replace non-standard and obsolete voice communications equipment. Implementation of this system will reduce costs, enhance operating efficiency and accommodate voice and data.

APPROACH: The Communications Control Systems for TCU's, TWR's and FSS's, will use commercially available systems adapted to ATS operational requirements. Provision will be made for a digital interface with the Controller and FSS Workstations. The system will allow offline reconfiguration of communications consistent with operational needs and will provide internal diagnostics and redundancy to reduce maintenance workload and system outages. Recording of transactions will be included. The design will be modular to support various sized ATS facilities. The system will provide a low speed digital link with remote facilities to support CPMS.

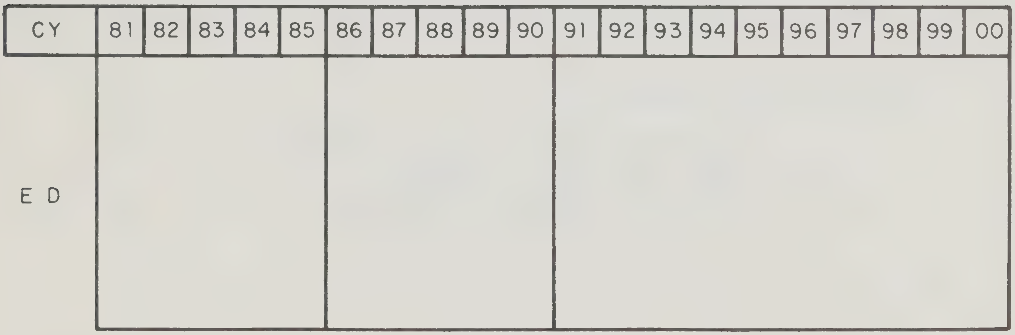
QUANTITIES: Transport Canada is under contract for the provision of 105 systems (involving some 360 workstations). An additional 80 systems will be procured between 1990 and 1993 to complete the replacement of existing systems.

RELATED PROJECTS/ACTIVITIES:

- Flight Information Services Automation
- Common Controller Workstations
- Control and Performance Monitoring System ICPMS)
- Speech Processing and Transmission Systems Development
- Flight Data Systems Modernization Project
- Telecommunication Network Investigations
- Canadian Aeronautical Digital Network
- Advanced Air/Ground Communication and Data Link Studies

COMMUNICATIONS CONTROL SYSTEM —
MODULAR AERONAUTICAL COMMUNICATIONS SWITCH (MACS)

SCHEDULE



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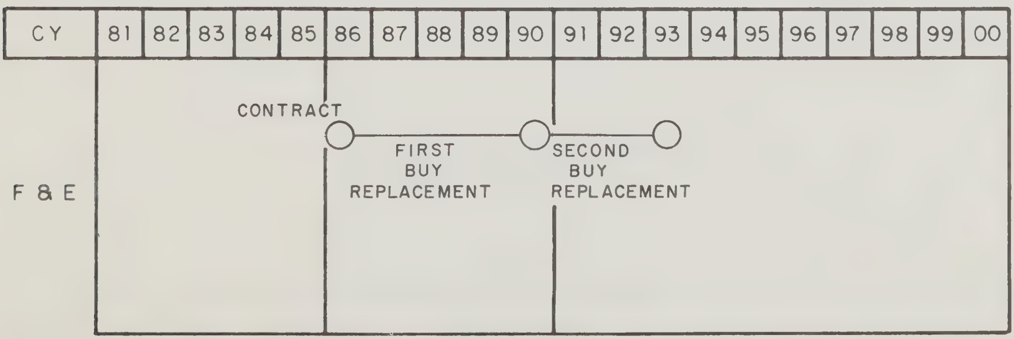


PROJECT: 8. LIFE EXTENSION
INTEGRATED COMMUNICATIONS CONTROL SYSTEMS (ICCS)

PURPOSE: To extend the useful life of the existing ICCS in regional Area Control Centres from 1995 to at least 2005.

ICCS currently provides the intrafacility voice links, as well as the interfacility and ground-air voice communications interfaces at the Area Control Centres.

APPROACH: Two alternatives were examined: a full replacement by 1995 or life extension by selective retrofit. Since ATS operational requirements for voice communications will not change during the period beyond year 2000, and since complete integration with other Area Control Centre systems in a Local Area Network would present major technical difficulties and since the benefits would not be sufficient to offset the difficulties, it was decided to extend the life of the equipment mainly by replacing the control processors, peripherals and the software.

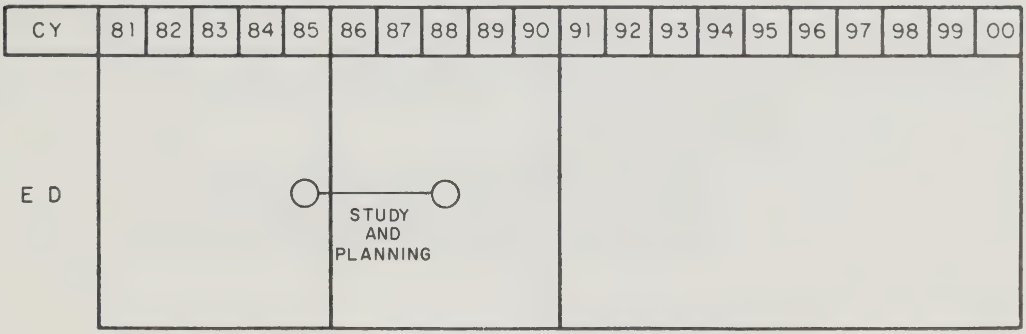
QUANTITIES: Seven operational systems, one training system in TCTI and one support system at the FESD Technical Systems Centre will be modified.

RELATED PROJECTS/ACTIVITIES:

- Telecommunications Network Investigations
- Common Controller Workstation
- Workstation Ergonomics Study
- Integrated Intrafacility Network

LIFE EXTENSION OF INTEGRATED COMMUNICATIONS CONTROL SYSTEMS (ICCS)

SCHEDULE



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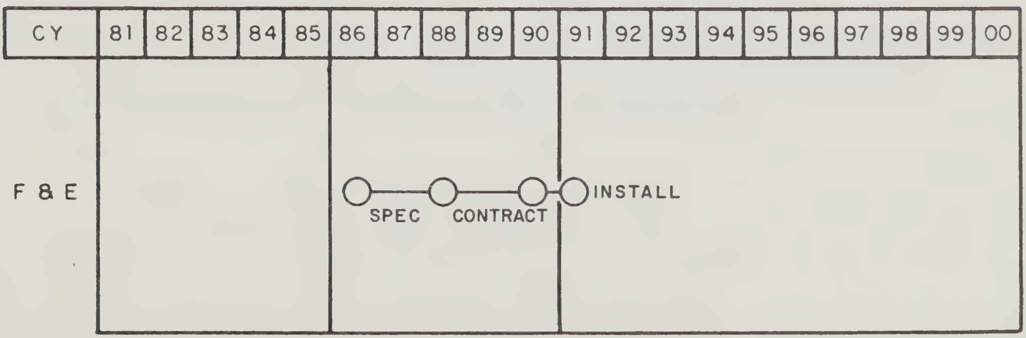


PROJECT: 9. TACTICAL CONFLICT ALERTING AND HAZARDOUS AIRSPACE WARNING (RADAR SENSOR DERIVED)

PURPOSE: To provide controllers with computer generated conflict prediction alerts and hazardous airspace warnings.

These functions will assist controllers by identifying potential conflict situations between Mode C transponder equipped aircraft, as well as alerting controllers to aircraft entering hazardous airspace.

These enhancements are prerequisites to computer generated conflict resolution advisory. The inclusion of these conflict alerting functions will provide added system safety during the period of increasing growth in air traffic.

APPROACH: Under the RAMP project software to perform these functions will be developed and implemented in the central processing complex of the Radar Data Processing Systems at the ACCs. At stand alone TCUs and TWRs software will be added to provide conflict alerting and hazardous airspace warning functions which will be distributed to the controller workstations via the local area network.

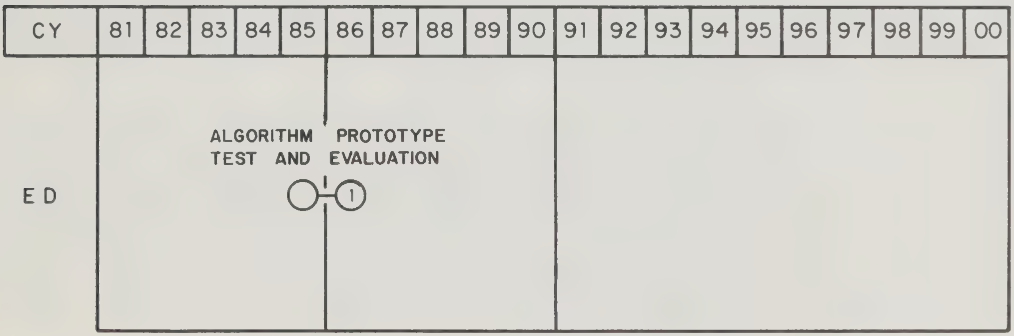
QUANTITIES: One high level language software package for use by RAMP DSEs and RDPSs, and in the Controller Training and Proficiency Evaluation Systems.

RELATED PROJECTS/ACTIVITIES:

- Radar Modernization Project (RDPS)
- Radar Modernization Project (DSE)
- Flight Data Systems Modernization Project
- Flight Data Processing Investigations

TACTICAL CONFLICT ALERTING AND HAZARDOUS AIRSPACE WARNING (RADAR SENSOR DERIVED)

SCHEDULE



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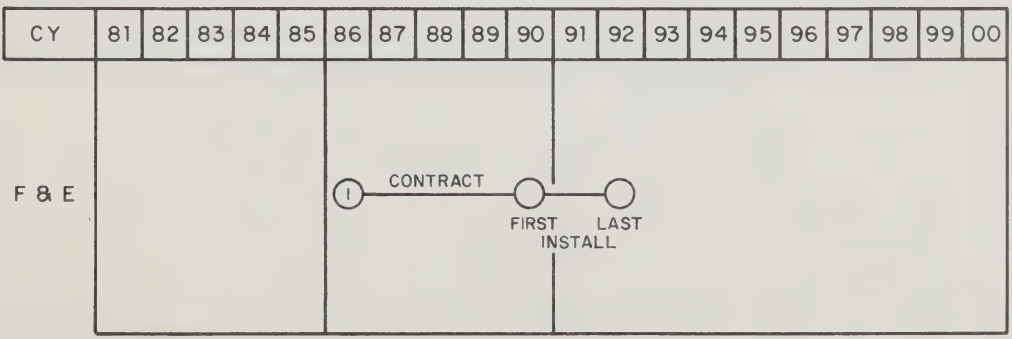


PROJECT: 10. COMMON CONTROLLER WORKSTATION

PURPOSE: To provide an integrated and versatile Common Controller Workstation capable of being operated by one controller.

The workstation will result in significantly increased controller productivity, and the combination of the central computer complex, distributed processing and partitioned software will provide increased system efficiency, reliability and availability.

APPROACH: Common Controller Workstations will provide controllers with electronic display of digital radar data, flight plan data, weather data, and supplementary aeronautical information. Scaled-down versions of the workstations (except for the displays) will be provided in TWR's, where daylight viewing displays will be used.

Air traffic situation displays (geographical and tabular), a planning and probe display, auxiliary displays and suitable interactive (touch-input) devices will constitute the controller workstation. Each workstation will be capable of operating autonomously in the event of failure of the central computer complex. The integrated system will be based on a central computer complex and distributed processing at each workstation. This system performs radar data processing, flight data processing, aeronautical data management and weather data processing. Multi-busses will carry data between the central computer complex and the workstations.

The software of the central computer complex will be reorganized and redistributed to ensure that critical air traffic surveillance data will always be available at the workstation. The central computer complex will be capable of expansion to accommodate future ATC enhancements. Previous separate hardware systems (RDPS, FDPS, etc) will eventually evolve into this integrated complex thereby eliminating redundant activities and improving overall system performance.

QUANTITIES: Number of Common Controller Workstations to be defined under the Flight Data Systems Modernization Project (FDMP)

7 Integrated Central Processing Complexes for the ACCs

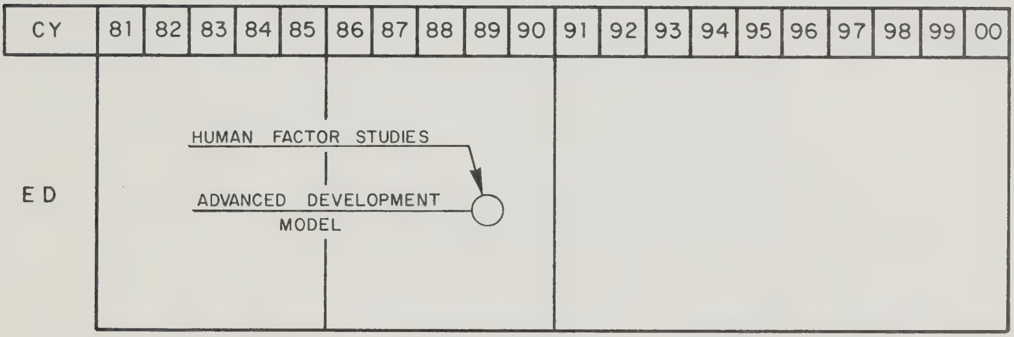
2 Integrated Central Processing Complexes for the TSC and TCTI

RELATED PROJECTS/ACTIVITIES:

- Aeronautical Information Processing System
- Aviation Weather Processor
- Radar Modernization Project
- Flight Data Systems Modernization Project
- Integrated Intrafacility Network
- Communications Control System
- Advanced Integrated ATC System
- Controller Training and Proficiency Evaluation System
- Workstation Ergonomics Study
- Artificial Intelligence/Expert Systems Investigations
- Aeronautical Information System Studies

COMMON CONTROLLER WORKSTATION

SCHEDULE



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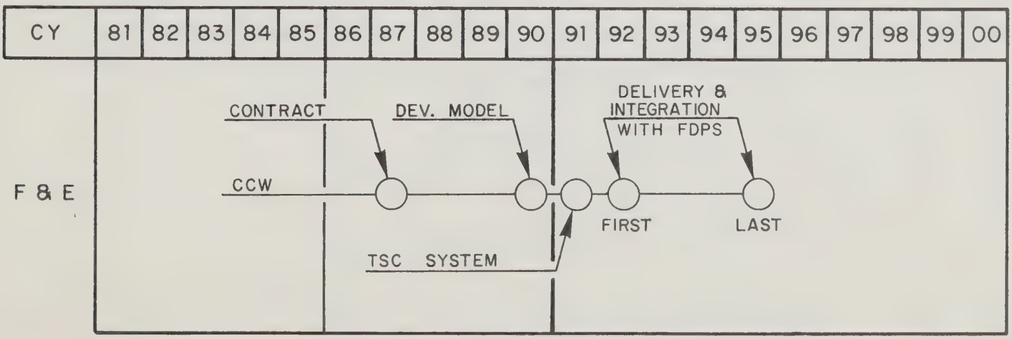


PROJECT: 11. RESEARCH AND EXPERIMENTATION CENTRE SYSTEM REPLACEMENT

PURPOSE: To enhance the capability of the present Research and Experimentation (R&E) Centre system in order to undertake the wider range of studies that will be needed in the future total systems engineering approach to modernization.

As ATS automated systems evolve, considerable use will be made of the R&E Centre to simulate and evaluate the introduction of new ATC functions and to study their impact on the operation. Studies, such as the introduction of conflict resolution, air-ground data transfer, automatic issuance of clearances, which will progressively alter the role of the controller, will have to be throughly proven before they are operationally used.

APPROACH: A replacement strategy has been developed based on the replacement of existing hardware and the rewrite of software to give a comprehensive capability and to take advantage of modern techniques. Early implementation of fast time simulation and additional mathematical modelling capabilities will be introduced. Along with the replacement of hardware, the system will be enhanced to undertake comprehensive human engineering studies that will be required to pace the development of the highly automated ATC systems of the 1990's. Appropriate hardware and software modules will be included to permit the study of wider applications such as Flight Service Station operations, user-friendly weather information access systems, and air-ground data link operations (including dependent surveillance and automatic clearances to aircraft). To enable the investigation of problems in the total integration of Air Navigation Systems, a flight simulator will be added to the R&E Centre.

Software packages developed for the R&E Centre system will be adapted for use in Controller Training and Proficiency Evaluation Simulation Systems.

QUANTITIES: Upgrading one R&E Centre System. Fast and real time simulation concepts developed for this system will be appropriately adapted for other systems with similar requirements.

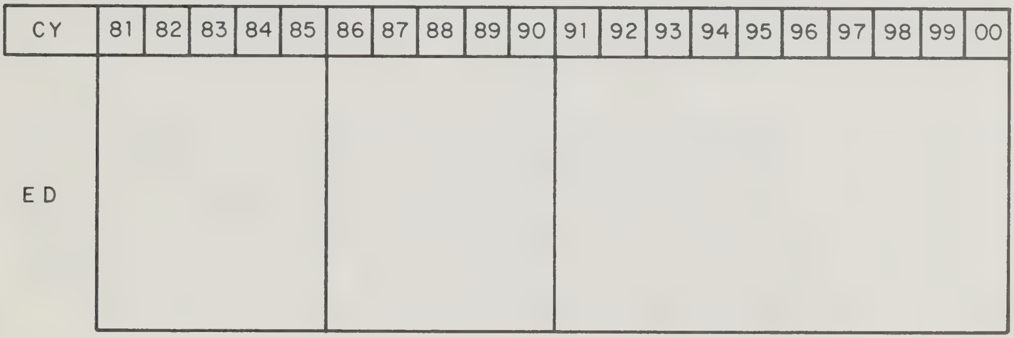
One general purpose flight simulator capable of simulating the performances characteristics of a wide range of aircraft types.

RELATED PROJECTS/ACTIVITIES:

- Controller Training and Proficiency Simulation System,
- Common Controller Workstation,
- Advanced Integrated ATC System
- Workstation Ergonomic Studies
- Flight Data Processing Investigations
- Technical Systems Centre
- Artificial Intelligence/Expert Systems Investigations
- Flight Data Systems Modernization Project
- Flight Information Services Automation

RESEARCH AND EXPERIMENTATION CENTRE SYSTEM REPLACEMENT

SCHEDULE



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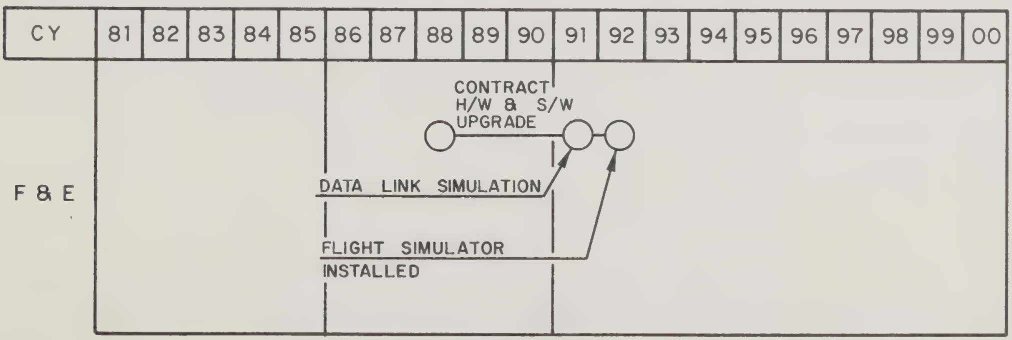


PROJECT: 12. CONTROLLER TRAINING AND PROFICIENCY EVALUATION SIMULATION SYSTEM

PURPOSE: To provide at TCTI, the Regions and ATC facilities, controller training and proficiency evaluation systems capable of realistically simulating ATC operations environments as these evolve.

As ATC Systems progressively become more automated, and as the role of the controller gradually changes to that of a system manager, it will be necessary periodically to evaluate controller proficiency and those skills, required in the event of automation degradation, through the use of realistic simulation. This approach is analogous to methods used for pilot training and proficiency checking.

APPROACH: As more ATC functions are automated, the system will need to be capable of accurately presenting operational scenarios. This will require the provision of suitable controller training and proficiency evaluation simulation systems which will be gradually phased in. Starting at the facility and regional level, replacement of the existing system (Regional Air Traffic Simulators) will be carried out to provide a system representative of ATC operations. These systems will be modelled on developments of the R&E system and will be down-sized but modularly compatible versions of the R&E system. The number of regional systems and their location is to be determined. The system at TCTI will be used to absorb unusual demands. This approach will enable greater standardization as well as more cost effective utilization of the regional systems.

At the ACCs and TCUs, operational ATC systems will be enhanced to provide "off-line" isolation of controller workstations (not in use during periods of low traffic activity) to be dedicated for essential job-related training. The on-site training system will be supported by a limited training target generation capability. For more comprehensive exercises (introduction of new operating procedures) linkage between "off-line" workstations and the regional simulator system will be provided.

At TCTI, replacement of hardware and upgrading of the system will parallel the developments of the R&E system. In the domain of ATC Tower simulators studies will be carried out to determine the best cost effective means for such training. Visual training systems for ATC Towers, which are truly representative of the real world, are still being researched, and their potential application for Canada's ATC training will be determined.

Computer Aided Learning will be extensively used in future ATS training systems.

Regional Communications Control Systems will be provided to complete the upgraded simulation requirements. This activity may be advanced to address current shortcomings.

APPROACH: Cont'd

QUANTITIES: Enhancement of systems at ATC facilities to enable "off-line" use of operational systems for controller training and proficiency evaluation.

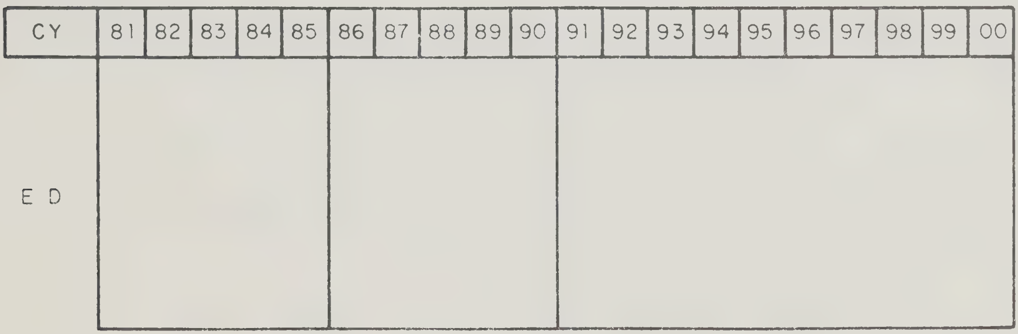
The number of Regional ATC training systems is unknown at this time. At TCTI, an advanced training system capable of supporting comprehensive multi-sector (controller work-station) ATC training, based on hardware and software common with and adapted from the R&E system. Visual (ATC Tower) training systems, to be determined.

RELATED PROJECTS/ACTIVITIES:

- R&E Centre System Replacement
- Advanced Integrated ATC System
- Common Controller Workstation
- Computer-Based Training Studies
- Artificial Intelligence/Expert Systems Investigations

CONTROLLER TRAINING AND PROFICIENCY EVALUATION SIMULATION SYSTEM

SCHEDULE



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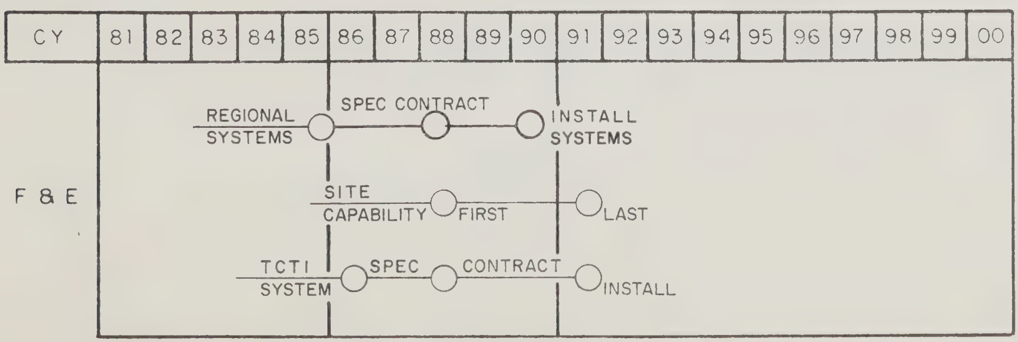


PROJECT: 13. INTEGRATED COMMUNICATIONS CONTROL SYSTEM TRAINING SIMULATOR

PURPOSE: These systems will be used simultaneously with other simulators to provide regional ATS with a realistic Area Control Centre offline training environment.

APPROACH: The system will be based on a DOT existing design which was licensed to industry. One system is already in place, another one is being procured as of 1985. The other systems will be bulk procured between 1987 and 1989.

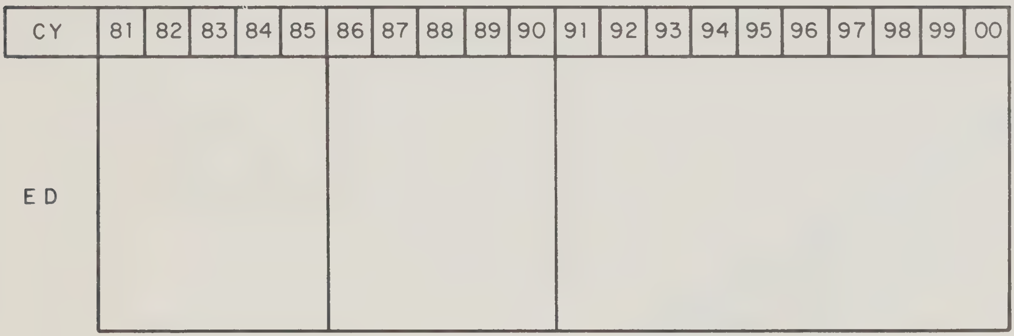
QUANTITIES: Ten systems will be bulk procured.

RELATED PROJECTS/ACTIVITIES:

- ICCS Life Extension
- Controller Training and Proficiency Evaluation Simulation System
- Computer-Based Training Studies
- Artificial Intelligence/Expert Systems Investigations

INTEGRATED COMMUNICATIONS CONTROL SYSTEM (ICCS) TRAINING SIMULATOR

SCHEDULE



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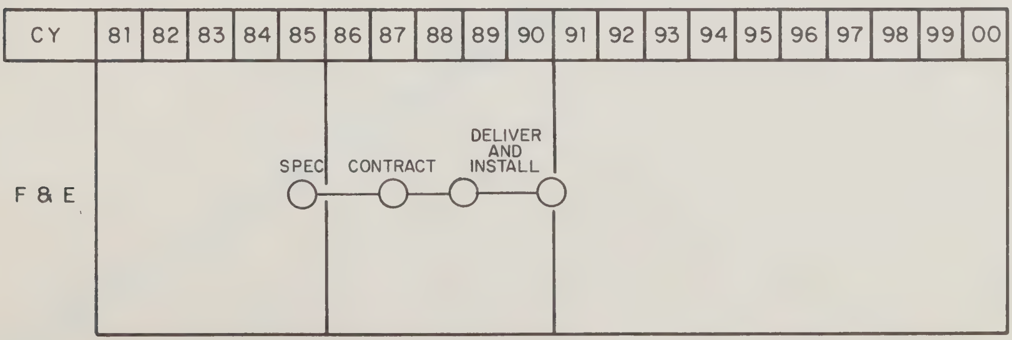


CHAPTER 4

FLIGHT SERVICE SYSTEM

CONTENTS

ILLUSTRATIONS

FLIGHT SERVICE SYSTEM

4.1 GENERAL

The flight service system encompasses all those services and facilities which provide information and advice to assist the pilot in the planning and conduct of his flight. The provision of such information is a primary responsibility of the Flight Service Station (FSS).

Aeronautical services and information are available to all sectors of the aviation community. Major airlines access certain flight information from source for internal distribution, whereas the remainder of the aviation community depend on the Flight Service Station to provide all the required information and services direct to the pilot.

Canada has approximately 110 Flight Service Stations offering a broad range of preflight and inflight services.

- Accepting and closing flight plans.
- Briefing pilots.
- Enroute communications with pilots.
- Assisting pilots in distress.
- Disseminating aviation weather information.
- Status monitoring of air navigation radio aids.
- Originating notices to airmen.
- Working with Search and Rescue (SAR) units in locating missing aircraft.

In addition, many stations also:

- Provide VHF direction finder service.
- Observe and collect Weather Data.
- Disseminate aviation weather reports.
- Arrange customs service for transborder flights.
- Provide advisory information to arriving and departing aircraft.
- Provide positive vehicle advisory service at uncontrolled airports
- Relay ATC clearances and IFR position reports.

The typical FSS is a one-position station located at an airport, operates 24 hours per day and employs 6 Flight Service Specialists. Some stations, because of workload or special requirements, operate two or more positions.

Interfacility data communication is provided by two national fixed telecommunications systems. One is used solely for the transmission and reception of weather data. The other is used for the relay of flight plan data, NOTAM's and related flight plan information. Interphone links between FSS's and air traffic control units enable the immediate exchange of flight data.

4.1 GENERAL Cont'd

Aeronautical information is provided to pilots from the Flight Service Station by pre-recorded and live broadcasts, by telephone or radio contact and person to person briefings. This information is then used, by the pilot, to file a flight plan with the Flight Service Specialist.

The flight plan is then transmitted to the appropriate ATS units. In the event that the flight fails to arrive within the prescribed time, action is initiated to conduct a communications search and alerting information is passed to the appropriate FSS/ACC and Rescue Coordination Centre.

4.2 THE NEW APPROACH

A Flight Information Services Automation project (FISA) will be implemented to improve the efficiency and effectiveness of flight services through greater use of automation techniques.

The weather observation and dissemination service will be modernized through the use of Automatic Weather Observing Systems (AWOS). AWOS are currently being evaluated as a means to assist or if possible to replace the human observer at Flight Service Stations, and to provide weather observations at other locations in both controlled and uncontrolled airspace that do not have an existing weather observation capability. These systems will be installed across Canada and will automatically collect and disseminate weather information; the weather data will be distributed locally and will also be transmitted through a new communications system, the Canadian Aeronautical Digital Network (CADIN) to a weather processor. The processed aviation weather forecasts and reports will then be forwarded and stored in regional aviation weather procesors. This weather information will be available at Flight Service Stations and will also be made available to pilots through Direct User Access Terminals (DUAT) or by telephone. The DUAT's will eventually be linked to flight planning processors enabling 'one-stop' service for all flight planning requirements, including the filing of the flight plan itself.

The Flight Service Specialists' workstations will be modernized and use will be made of the Common Controller Workstation design wherever possible. The resulting ergonomically designed Specialist workstation will incorporate modern displays and controls, permitting the Specialist to perform his role in an efficient manner.

The planned automation and modernization of flight services will permit the consolidation of stations. Unmanned stations will consist of Flight Planning Offices, Remote Communications Outlets (RCO) and Remote Flight Service Stations (RFSS). Flight Planning Offices will simply contain a DUAT accessible to pilots; RCO's will provide enroute communications services;

4.2 THE NEW APPROACH Cont'd

and RFSS's will provide both enroute and ground advisory communications services; both RCO's and RFSS's will be controlled from Hub Flight Service Stations. Other Flight Service Stations, that have no responsibility for controlling remote stations, will continue to exist. The 'Hubbing' technique will permit a substantial increase in the productivity of FSS personnel.

4.3 EVOLUTION OF THE SYSTEM

CURRENT PROGRESS (TO 1985)

Mass dissemination techniques such as cablevision and commercial TV (CBC North) station broadcast and commercial videotext (TABS) are being employed in high population areas to make pre-flight information, including weather, readily accessible to the aviation community. The availability of this information at a place, time, and at a pace most receptive to the pilot, has greatly enhanced flight planning effectiveness and therefore flight safety. As an additional aid to pilots, toll-free telephone access is now available for flight planning purposes at all FSSs.

AWOS are being evaluated to supplement or replace the human observer role at Flight Service Stations. This is a major step in the FSS automation/modernization program which will permit the future consolidation of facilities.

The fixed telecommunications network, which ties all manned facilities together, is being upgraded to provide additional capacity at greater speed as part of the evolution to CADIN (see Chapter 7). This will ensure the timely exchange of all aeronautical information and more current and accurate data banks.

30 RFSS's established at airports are providing airport and vehicle advisory services, thereby reducing the need for manned facilities. In addition, 57 RCO's now exist to provide enroute pilot communications.

Automated systems are largely in the development or early implementation stage. First generation Meteorological Information Display Systems (MIDS) have been installed in the Ontario Region for evaluation purposes. These systems greatly enhance the reception and distribution of aviation weather data. Development of the system to encompass flight planning capabilities is underway such that MIDS will evolve into a multipurpose information display system.

NEAR TERM (TO 1990)

A Flight Information Services Automation Project will be established with the task of integrating all aspects of modernization including all related 'weather' systems.

Through further automation, a number of Flight Service Station Hubs will be established to operate in conjunction with remote FSS's. The remote FSS's will be operated with a minimum of on-site maintenance and operations personnel. By 1990 the number of manned FSS's will be considerably reduced. It is also anticipated that further privatization of flight planning services will take place.

Initially, the Flight Service Specialist will have information display terminals in order to select (by location, area and flight route) locally stored current aviation weather reports, forecasts, NOTAM and flight data for use at the workstation and at the briefing position to assist pilots with pre-flight planning. A subsequent phase will see FSS workstations and DUAT's linked to regional aeronautical information and aviation weather data bases, thereby providing all necessary pre-flight information.

Aviation weather information will also be available by telephone access to computer generated voice response systems linked to aviation weather data bases. In addition to the normal flight information service, in areas where circumstances warrant, an Enroute Weather Advisory Service (EWAS) will be established on a separate frequency. Calls on this frequency will be responded to by an FSS aviation weather briefing specialist.

The first Modular Aeronautical Communications Switch (MACS) will be installed in 1988. This system will integrate all voice circuits and will enhance all aspects of the control and monitoring of remote facilities. The modularity of the system will facilitate future expansion or reduction in the number of voice circuits at a station, to permit position consolidation or expansion due to workload fluctuations.

By the spring of 1987 the Gander Automated Flight Service Station will be commissioned. This system will automate the handling, storage and retrieval of air-ground messages. The Gander FSS is unique in Canada and the automation underway will not be applicable to other FSS's.

LONG TERM (TO 2000)

This period will see the full realization of the station Hub concept through extensive use of automated systems. These station Hubs will provide comprehensive flight services over a wide geographic area. Unmanned and part-time manned remote FSS's located at airports will be operated through the Hub. The DUAT at the remote and other flight planning locations (flight dispatch office, pilot lounge, etc.) will now be able to provide all pre-flight information as well as accept flight plans. Flight plans will be entered directly into the Flight

4.3 EVOLUTION OF THE SYSTEM Cont'd

Data Processing System (FDPS) through either the FSS workstation or the DUAT's. Further dissemination and presentation of the flight plan data will be accomplished automatically by the FDPS.

The FSS workstation will be developed during this time-frame. This integrated workstation will be ergonomically designed and will have as much in common with the Common Controller Workstation (see Chapter 3) as possible.

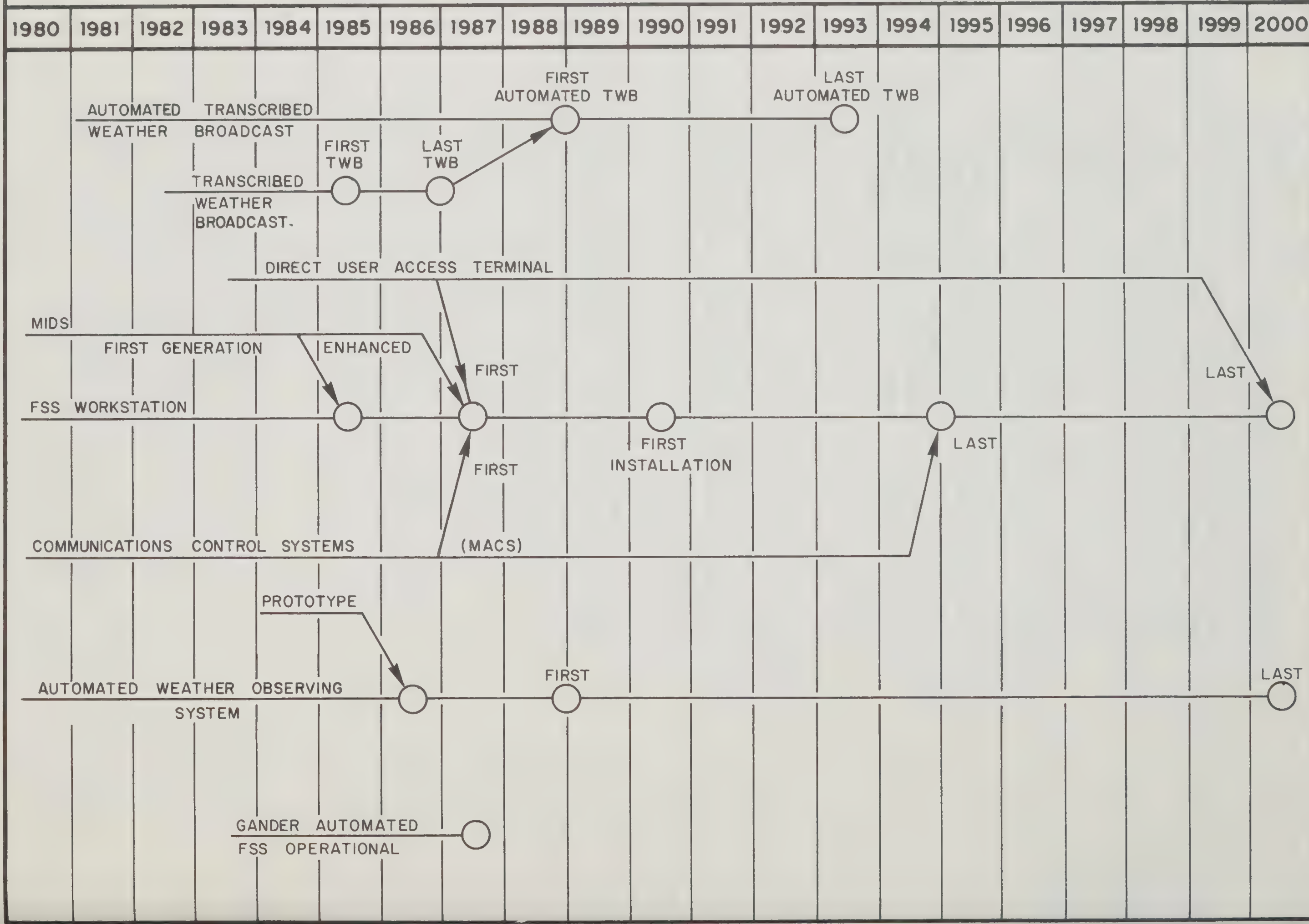
Real-time weather data, including radar derived weather information will be graphically displayed at FSS's and on DUAT's. The display of weather data derived from U.S. radars (NEXRAD) is also a possibility (see Chapter 6). The graphic display of weather data will improve pre-flight and enroute briefing services and assist pilots in avoiding hazardous weather.

4.4 BENEFITS OF THE PLAN

As a result of planned actions, operations costs will be significantly reduced; productivity will increase; and service to the aviation community will keep pace with the forecast growth in demand.

As automation systems are implemented commencing in 1987, systems such as AWOS and DUATS will enable consolidation of facilities to begin such that there will be no growth, and a possible reduction, in person-year requirements.

FIGURE 4.1. FLIGHT SERVICE SYSTEM EVOLUTION



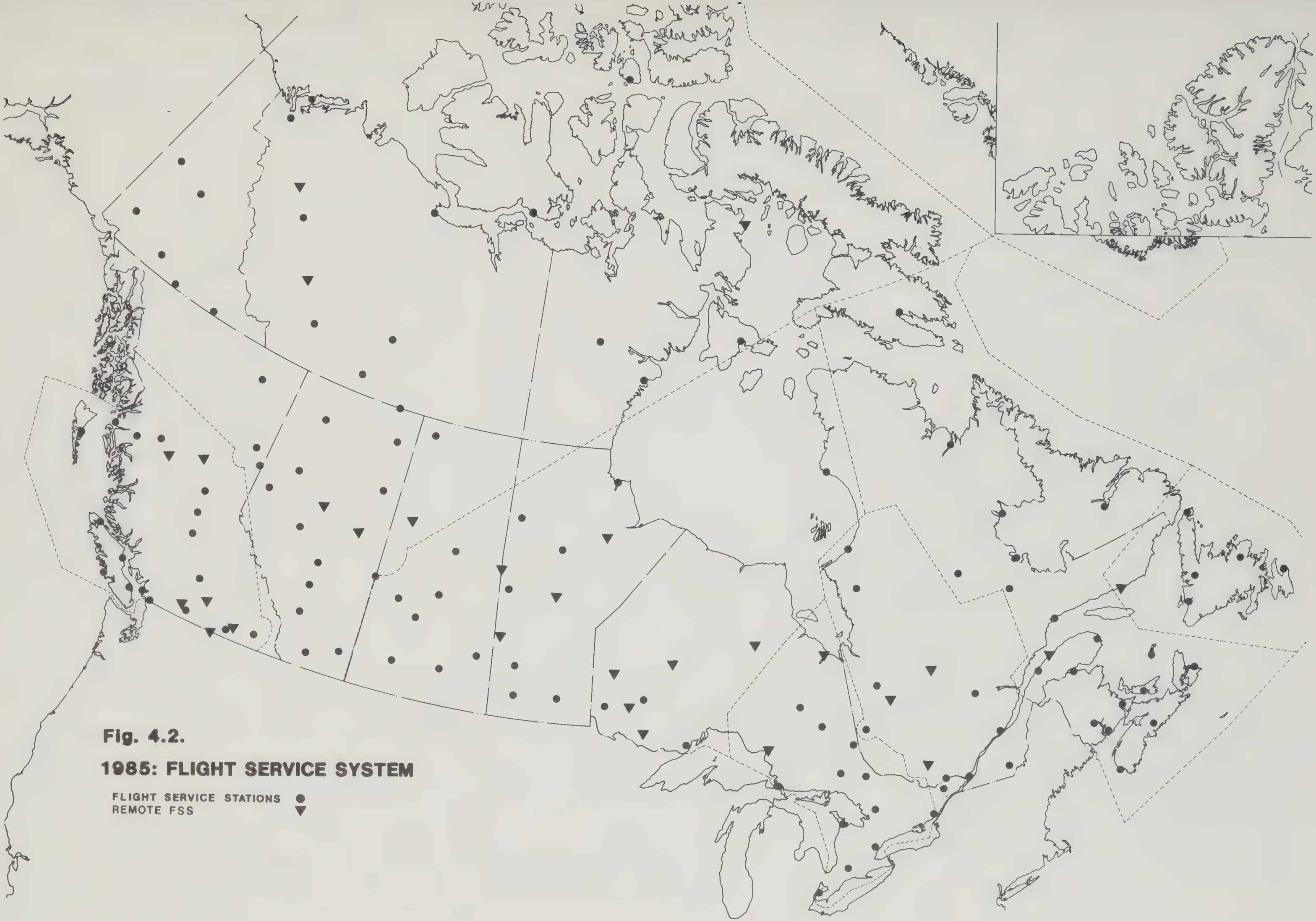


Fig. 4.2.

1985: FLIGHT SERVICE SYSTEM

FLIGHT SERVICE STATIONS ●
REMOTE FSS ▼

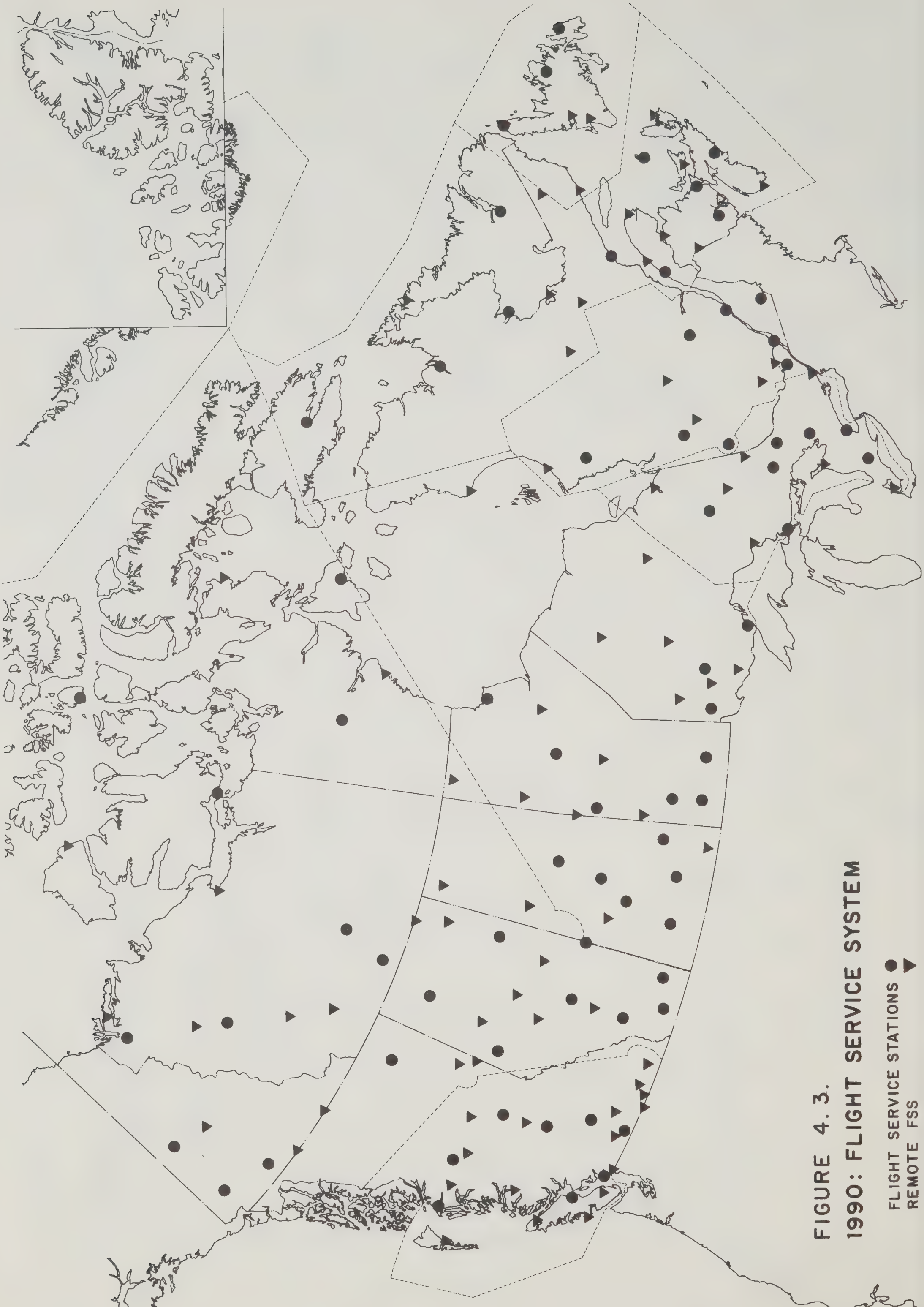


FIGURE 4.3.
1990: FLIGHT SERVICE SYSTEM

FLIGHT SERVICE STATIONS ●
REMOTE FSS ▼

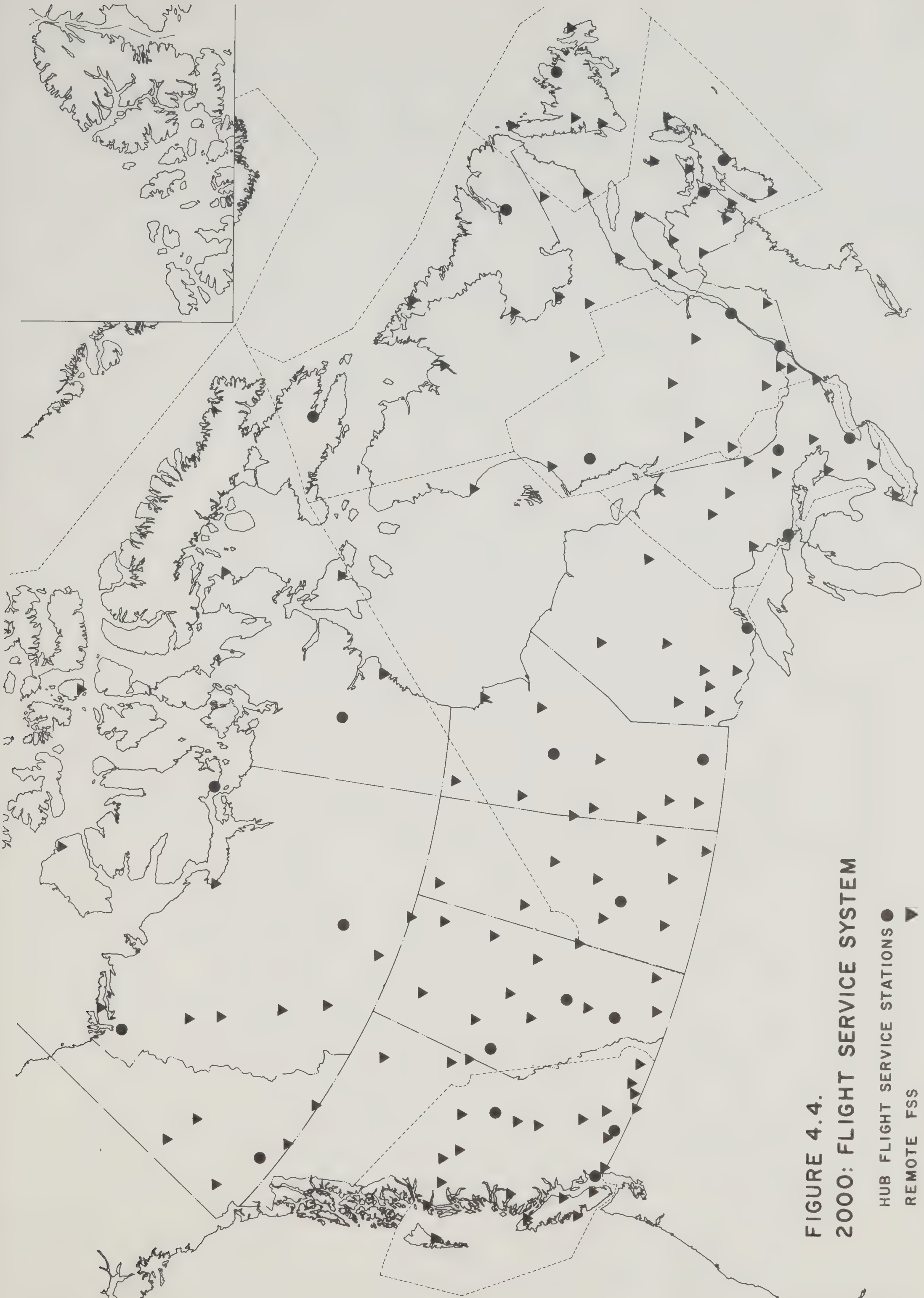


FIGURE 4.4.
2000: FLIGHT SERVICE SYSTEM

HUB FLIGHT SERVICE STATIONS ●
REMOTE FSS ▲

4.5 FLIGHT SERVICE SYSTEM PROGRAM OF PROJECTS

PROJECT	Implementation	
	First	Last
1. Gander Automated FSS	1987	1987
2. Multi-purpose Information Display System	1985	1988
3. Flight Information Services Automation		
(a) Specialist Work Station	1990	2000
(b) Direct User Access Terminal (DUAT)	1987	2000
(c) Automated Weather Observing System (AWOS)	1988	2000
(d) Automated Transcribed Weather Broadcast	1989	1993

PROJECT: 1. GANDER AUTOMATED FSS (GAFSS)

PURPOSE: To automate air-ground message handling, storage and retrieval, and to reduce ambient noise level in the operations room.

The Flight Service Station at Gander employs 55 specialists providing air-ground communications with international (North Atlantic and Polar) flights on 4 ICAO assigned HF families of frequencies.

APPROACH: The system will utilize new Video Display Terminals for message formatting and a computer controlled data switch. The GAFSS design will allow for the integration of satellite and HF data link as it evolves.

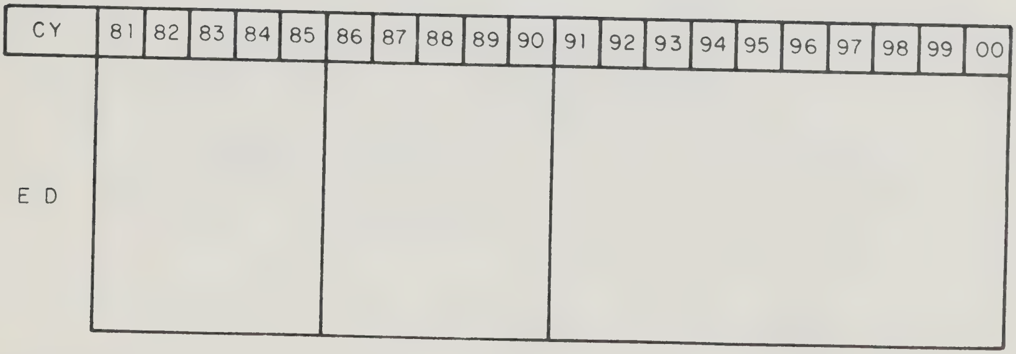
QUANTITIES: 1 system.

RELATED PROJECTS/ACTIVITIES:

- Gander Automated Air Traffic System.
- Workstation Ergonomic Studies
- Network Reconfiguration and Integration.
- Canadian Aeronautical Digital Network.
- Flight Information Services Automation
- Aeronautical Information Systems Studies
- Aeronautical Information Processing System
- Weather Detection, Processing and Dissemination Systems
- Advanced Air/Ground Communication and Data Link Studies

GAFSS

SCHEDULE



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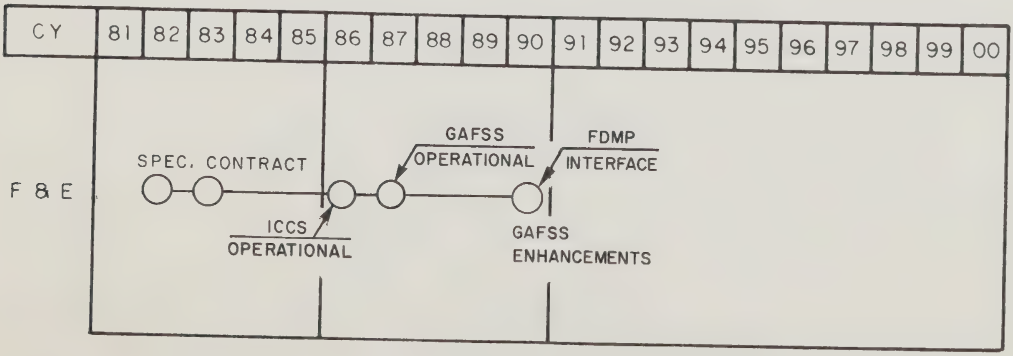


PROJECT: 2. MULTIPURPOSE INFORMATION DISPLAY SYSTEM (MIDS)

PURPOSE: To provide an interim solution to the present manual and inefficient weather and flight data management procedures used at all FSSs.

While providing a useful operational function MIDS also serves as a prototype FSS workstation for development purposes. Also, MIDS has the potential to serve as a DUAT for a variety of users outside of the FSS.

APPROACH: The first generation MIDS, which processes weather data only, is operational. An enhancement program is underway that will add NOTAMS, flight planning, graphics and statistics to the MIDS capabilities. A limited DUAT capability will also be tested. All of the above development will lead to a fully integrated workstation.

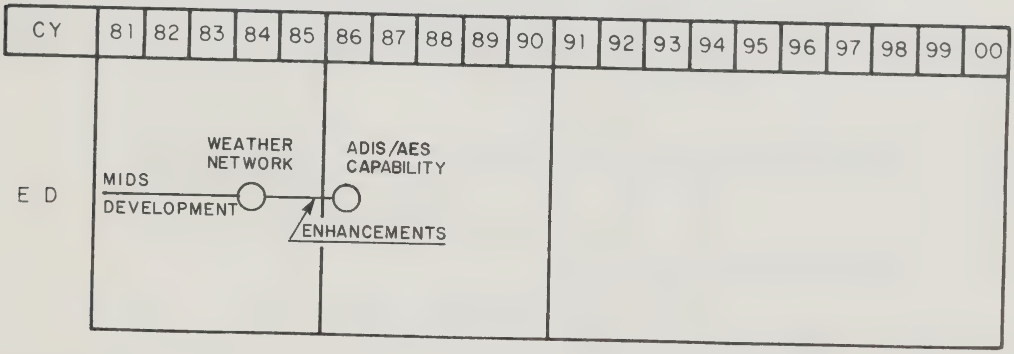
QUANTITIES: Approximately 100.

RELATED PROJECTS/ACTIVITIES:

- Workstation Ergonomics Studies
- DUATS
- Aviation Weather Processors
- Aeronautical Information Systems Studies
- Aeronautical Information Processing System
- Weather Detection, Processing and Dissemination Systems

MIDS

SCHEDULE



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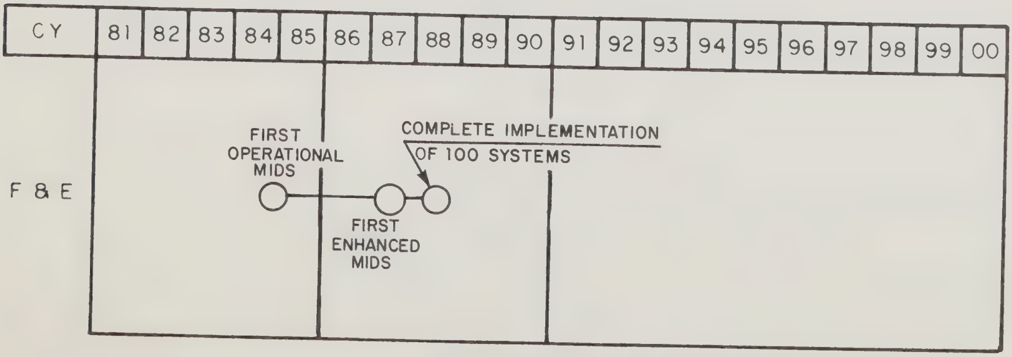


PROJECT: 3(a) FLIGHT INFORMATION SERVICES AUTOMATION: SPECIALIST WORK STATIONS

PURPOSE: To provide FSS communications and briefing positions, taking advantage of state-of-the-art technology and automated systems. The modern automated FSS will require flexible and expandable work stations to meet varying workload and staffing situations. Following interim changes to current work stations to accommodate MIDS II, MACS and EWAS a standard work station design will be developed, significantly increasing Flight Service Specialist productivity. The application of automation within the work station will increase system efficiency, reliability and availability.

APPROACH: Integrated information and operations control systems will provide the specialist with weather radar and VHF-DF displays, navaid status, current and forecast weather information. Switching of radio frequencies and other voice communications will be accomplished through the Modular Aeronautical Communications Switch (MACS). Work stations will be connected to the flight data processor for reception/input of filed flight plans and to the aeronautical information and aviation weather data base for NOTAM, facility status and aviation weather. Input/output devices such as Video Display Terminals and hard-copy printers will be used. The work station design will allow for modular expansion, both in function and capacity. Engineering development on meteorological information display techniques and intelligent terminals is already underway.

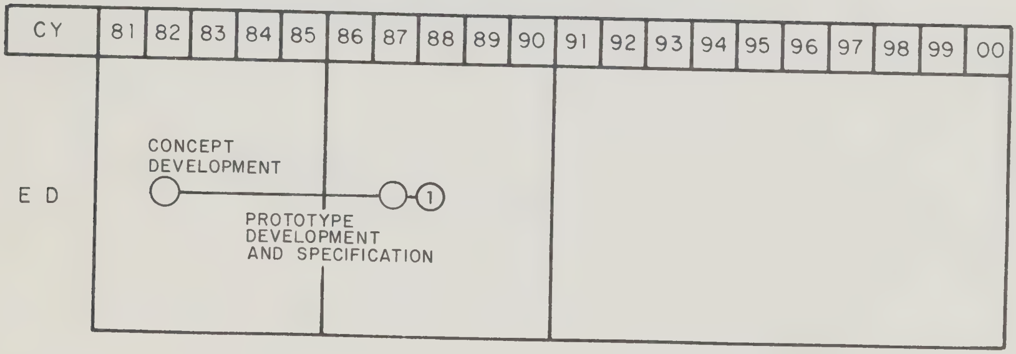
QUANTITIES: To be determined when the number of manned stations is finalized.

RELATED PROJECTS/ACTIVITIES:

- Communications Control System. (MACS)
- Common Controller Workstation.
- Multi-purpose Information Display System (MIDS)
- Workstation Ergonomics Studies
- Computer-Based Training Studies
- Artificial Intelligence/Expert Systems Investigations

FSS WORKSTATIONS

SCHEDULE



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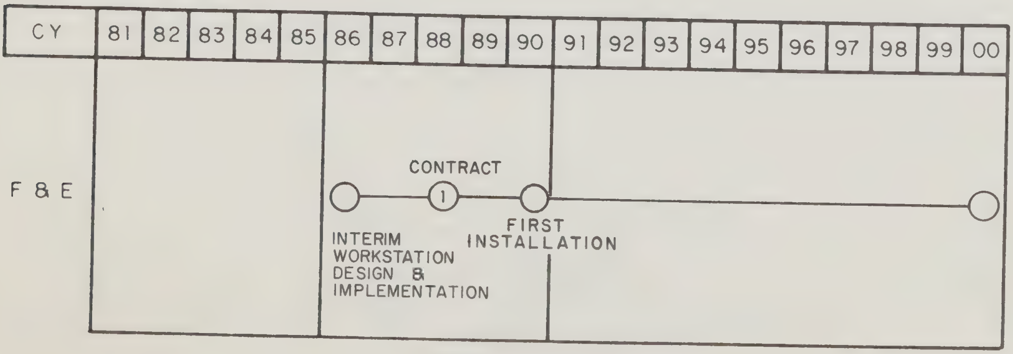


PROJECT: 3(b) FLIGHT INFORMATION SERVICES AUTOMATION: DIRECT USER ACCESS TERMINAL (DUAT)

PURPOSE: To provide users (aircraft operators and pilots) with direct access to preflight information and flight plan filing. The availability of information at a time, place and pace most receptive to the pilot will greatly enhance flight planning effectiveness and permit the more effective and efficient employment of FSS personnel.

APPROACH: Video display terminals will be provided at remote FSS's and selected pilot briefing stations. Interfaces established with aviation weather, flight planning and aeronautical information processors will allow for direct access by these VDT's. Interfaces will also be established to allow for user provided VDT access. Telephone access will also be accommodated.

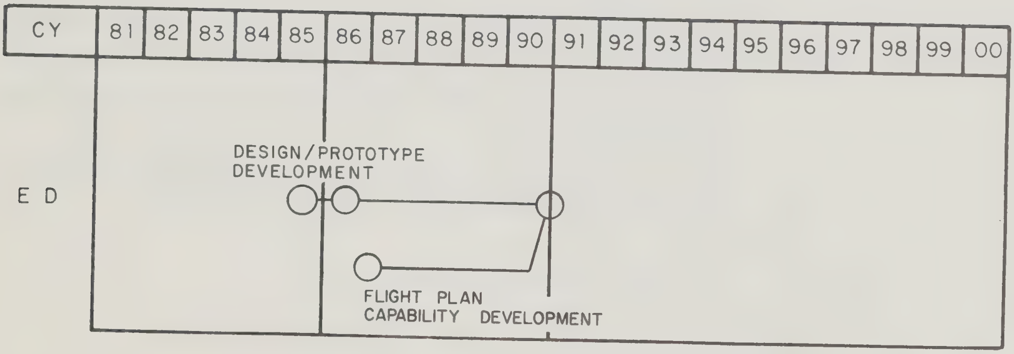
QUANTITIES: To be determined.

RELATED PROJECTS/ACTIVITIES:

- Workstation Ergonomics Studies
- Flight Data Systems Modernization Project
- Multi-purpose Information Display System (MIDS)
- Canadian Aeronautical Digital Network

DUAT

SCHEDULE



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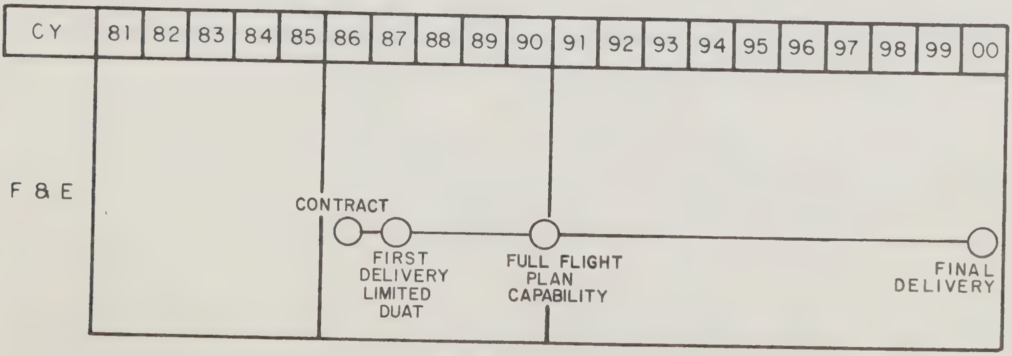


PROJECT: 3(c) FLIGHT INFORMATION SERVICES AKUTOMATION: AUTOMATED WEATHER OBSERVING SYSTEM (AWOS)

PURPOSE: To implement systems which will use automatic weather sensors to provide standard aviation weather observations. These systems will output in 2 Modes:

- Meteorological observations to be fed directly to Regional Aviation Weather Processors and AES Weather Processors.
- In voice form to allow broadcast on navigation and communication facilities.

AWOS will permit establishment of remote FSS, provide 24 hour weather observing from isolated locations and reduce the weather observing workload of personnel at manned sites.

A first generation AWOS is presently being evaluated in Canada and other systems are being tested by the FAA.

APPROACH: The order of priority for the establishment of AWOS will be:

- Locations which provide partial or no weather observations.
- Manned locations, whose replacement will facilitate site consolidation.
- Manned FSS Hubs which will increase Flight Service Specialist productivity.

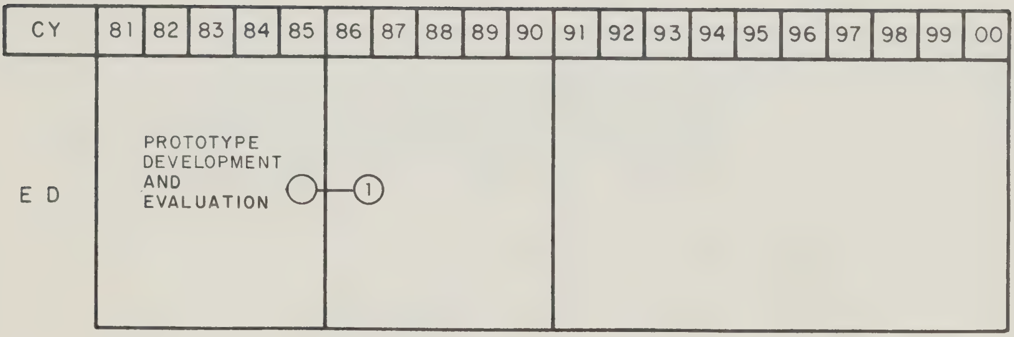
QUANTITIES: 43 systems in first procurement.

RELATED PROJECTS/ACTIVITIES:

- Primary and Standby Power Systems.
- Weather Detection, Processing and Dissemination Systems

AWOS

SCHEDULE



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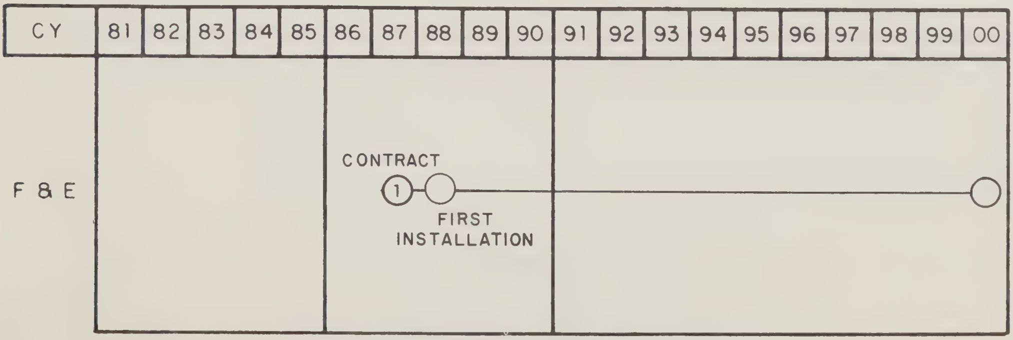


PROJECT: 3(d) FLIGHT INFORMATION SERVICES AUTOMATION: AUTOMATED TRANSCRIBED WEATHER BROADCAST

PURPOSE: To provide for the mass dissemination of aviation weather information and other aeronautical information for use at the preflight and inflight stages.

APPROACH: Two types of weather dissemination system are under development and both use an Electronic Speech Generator (ESG). The first type, a Transcribed Weather Broadcast, requires the operator to input a voice message which is digitized, stored and repeatedly broadcast. The message is segmented so that it can be selectively updated without complete re-recording. The second type, an Automated Transcribed Weather Broadcast, uses a resident vocabulary to compose a voice message based on input information. This technique allows updating of one or more systems through direct input from communications networks without human intervention. All TWBs are accessible by telephone as well as by reception of the selected broadcast facility. A prototype TWB with an ESG is being evaluated.

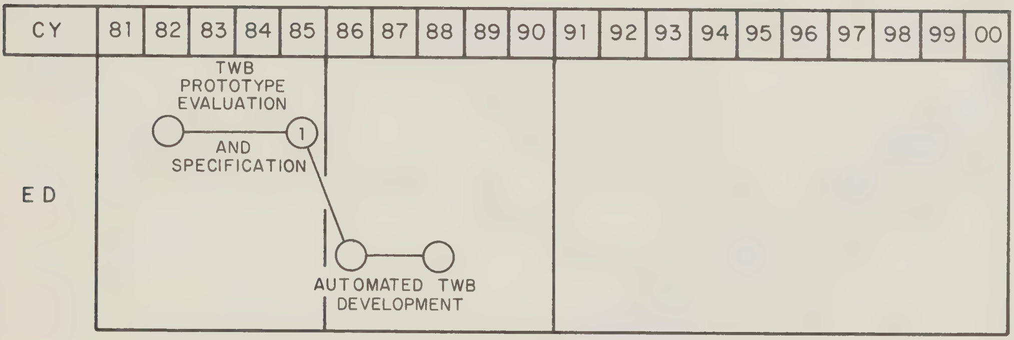
QUATITIES: To be determined.

RELATED PROJECTS/ACTIVITIES:

- Automated Weather Observing System
- Weather Detection, Processing and Dissemination System
- Speech Processing and Transmission Systems Development
- Artificial Intelligence/Expert Systems Investigations

AUTOMATED TRANSCRIBED WEATHER BROADCAST

SCHEDULE



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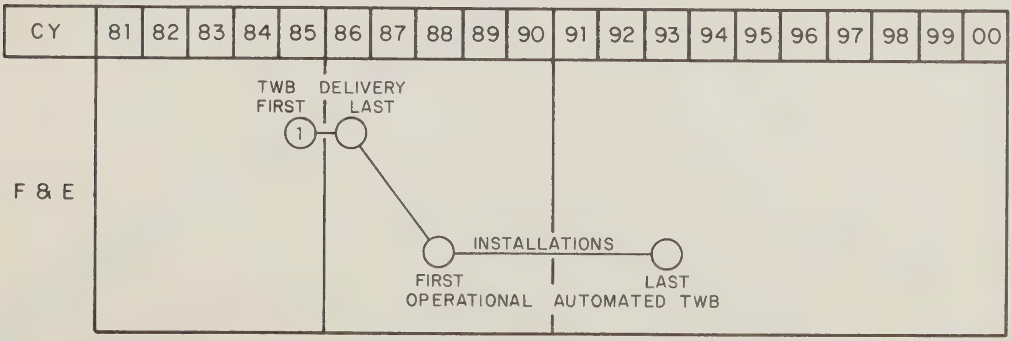

CHAPTER 5

AVIATION WEATHER SYSTEM

CHAPTER 5 AVIATION WEATHER SYSTEM

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ILLUSTRATIONS

FIG.

CHAPTER 5 AVIATION WEATHER SYSTEM

5.1 GENERAL

The Federal Government agency responsible for providing meteorological services is the Atmospheric Environment Service (AES) of Environment Canada. AES is responsible for the provision of resources to meet the needs of their CORE stations; Transport Canada is responsible for requirements in excess of CORE station needs. Aviation weather service is provided through several agencies including: AES, TCAG's Flight Service Stations (FSS), Arctic Aviation Weather Reporting Stations (AAWRS), Contract Aviation Weather Stations (CAWS), Private Aviation Weather Reporting Stations (PAWRS) and Community Aerodrome Radio Stations (CARS). AES offices located at airports may provide aviation weather briefings, but the prime disseminators of weather information to aircraft operators are the FSS specialists. AAWRS and PAWRS personnel are trained and periodically evaluated by AES. Transport Canada identifies the operational requirements and provides funding for the AAWRS, but the personnel manning is a responsibility of the Territorial government. PAWRS must meet CATA specifications for approval. They are funded and manned by non-federal sources to satisfy localized aviation requirements, except in special cases, where a specified level of service is provided, some federal assistance and funding will be provided.

There are approximately 300 locations throughout Canada that take weather observations. Less than half provide hourly weather reports 24 hours per day. The remainder provide from as many as 18 to as few as 4 observations per day. Some isolated sites provide observations only on demand. Therefore, the detailed aviation forecasts that are issued four times per day are prepared, at times, from information derived from observations taken from less than 50% of all the locations. Additional weather observations are taken at approximately 200 locations by commercial operators on an as-required basis to meet the requirements of the specific air carrier's operating certificate. These observations are not now being gathered or recorded for any other operational, forecasting or historical use. If collected, retained and disseminated, this information would add significantly to the aviation weather data base.

An excellent source of aviation weather data are pilot reports (PIREPS) provided by aircrew involved in daily flying operations. These timely reports are normally relayed to ATS facilities and if disseminated serve as an excellent source of information on weather phenomena that cannot be viewed or experienced from the ground, for example: cloud tops, cloud layers, turbulence, freezing precipitation layers, ceilings, visibilities, etc. PIREPS are not used by AES in preparation of aviation weather forecasts or reports to the extent they could be; nor does their creation receive adequate priority by aviators.

5.1 GENERAL Cont'd

Weather information is collected manually except for some limited data provided by approximately 60 AES automatic devices located across Canada. This information is transmitted to the AES weather computer (Toronto) which distributes it to appropriate ATC, FSS and other agencies. The computer also analyzes and processes it into basic weather forecast information before being retransmitted to area weather offices located across Canada. The aviation weather forecasts are then prepared in the area offices and subsequently disseminated to various subscribers including ATC facilities, FSS, AAWRS, PAWRS, CAWS and commercial operators. In addition satellite and AES weather radar data contribute significant information for aviation weather forecasts while TC radars provide real time imagery of existing weather conditions.

Pilots acquire weather information from the various agencies primarily by phone or by personal contact. Additional information is available while airborne or on the ground through Transcribed Weather Broadcasts (TWBs), air-ground radios, commercial TV and radio weather programs, Automatic Terminal Information Service (ATIS), and various other auxiliary systems. In areas where there is a high volume of air traffic, dissemination of aviation weather to the pilot is a major problem as phones are generally busy and most public weather reports on radio and TV are not of the quality required for aviation.

5.2 THE NEW APPROACH

Aviation weather service will be improved in quality and timeliness through automation. Selected sites will be fitted with Automated Weather Observing Systems (AWOS) that will transmit aviation weather data to aviation weather processors. Various means of mass dissemination of aviation weather will be introduced. Dedicated video display terminals with keyboard access to aviation weather data banks will employ computer derived graphical displays to present weather in an easily interpretable format. Access to this "real time" weather information will be streamlined. Air Traffic Controllers and Flight Service Specialists will use automated display terminals to access aviation weather processors for pertinent information including the display of weather radar data. Eventually Direct User Access Terminals (DUATs) will be strategically located to provide a one stop flight planning service. The pilot's action of entering his intended flight profile into a DUAT will trigger the display of pertinent weather and enroute flight information. When satisfied that all flight planning options are resolved, the pilot will action the terminal to transmit the flight plan to the Flight Data Processing System (FDPS). Modern Automated Transcribed Weather Broadcast Systems will have aviation weather data digitally stored. This information will be continuously broadcast over designated radio systems by an electronic speech generator, or on demand by telephone. The user may either dial specific aviation weather sequences pertaining to his planned flight, or call up the full aviation weather briefing stored on a particular TWB.

5.2 THE NEW APPROACH Cont'd

Ease of access to real time accurate weather information will assist pilots in avoiding hazardous flight conditions. Weather information will be available in the aircraft on hard copy or display readout through air-ground data link. Increased accuracy of aviation weather forecasts will encourage pilots to navigate using minimum time tracks resulting in appreciable fuel savings. Some aircraft will relay, through data link, upper air wind vectors and other pertinent information to the ground system.

An evaluation will be conducted to determine if a Low Level Wind Shear Alert System (LLWSAS) has value in warning pilots on approach or departure of potentially hazardous flight conditions.

New weather processors will provide data to the FDPS meterological model. This will facilitate the provision of ATC clearances to flight planned or enroute aircraft. Avoidance of hazardous weather detected by radar will be similarly resolved. In the high density traffic areas a combination of AES, DND and TC radars will provide effective weather radar coverage at the lower altitudes and volumetric coverage at 18,000 feet and above. The weather detection capability of the new RAMP radars together with real time weather radar data from AES and DND will provide improved weather radar data essential for automated metering and sequencing of air traffic in busy terminal control areas. The flight service specialists work stations will also have access to this radar data to provide pre-flight and in-flight weather advisory service to pilots.

5.3 EVOLUTION OF THE SYSTEM

CURRENT PROGRESS (TO 1985)

Government sponsored commercial services for the mass dissemination of aviation weather have alleviated the accessibility problems of the past. Early morning TV weather programs in the North have been made possible through the use of satellites. In the Toronto area, a Telidon Aviation Briefing System (TABS) is under evaluation. TABS allows interactive access to weather graphics as well as NOTAMs. A limited number of new solid state memory TWB's have been introduced, that provide both a telephone access and radio broadcast capability.

Also, a few commercial agencies have established flight planning offices that offer weather briefing and flight plan filing services.

5.3 EVOLUTION OF THE SYSTEM

NEAR TERM (TO 1990)

Major improvements in the timeliness and volume of weather products available to users will be implemented during the next 5 years. Automatic weather observing systems will allow expansion of the data base used for forecasting and thereby improve the quality of terminal and area forecasts. In some AWOS "voice" generators will continuously broadcast local weather to assist pilots in the final stages of flight.

Air traffic services personnel, with the aid of systems like MIDS and aircraft operators, through DUATS, will be able to access pertinent aviation weather data on an interactive basis. While enroute, pilots will be able to acquire aviation weather from AWOS, Automatic TWBs or through use of dedicated FSS Enroute Weather Advisory Service (EWAS). The dedicated VHF channel will also serve to improve the exchange and dissemination of pilot weather reports (PIREPS). The installation of primary surveillance radar at TCUs plus the provision of AES weather radar data will enable ATS personnel to accurately identify areas of hazardous weather.

LONG TERM (TO 2000)

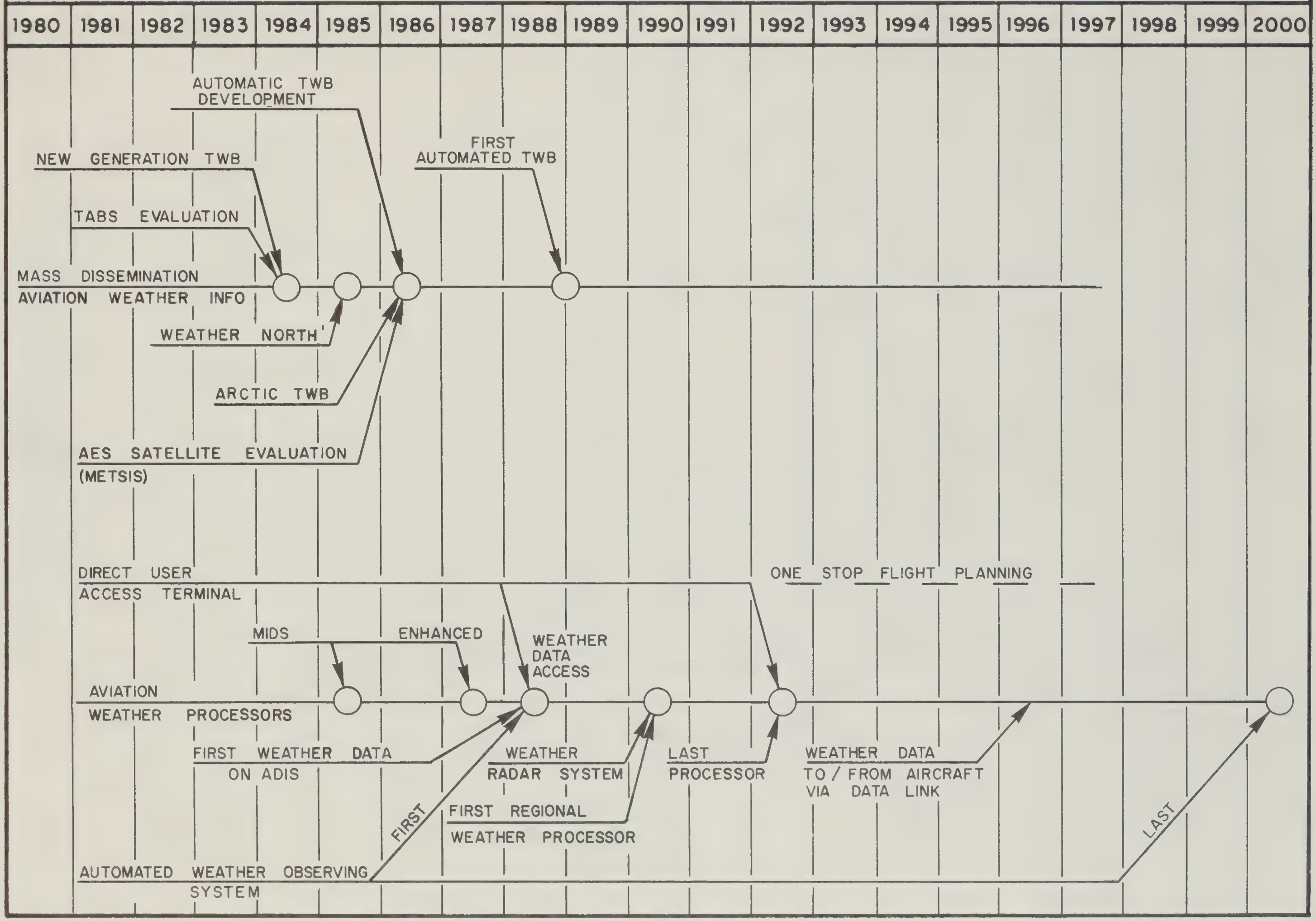
As more AWOS are installed across Canada, the number of weather observations will increase considerably. The additional data will improve the quality and accuracy of aviation weather forecasts. Automatic airborne meteorological sensors installed on selected aircraft will communicate, on demand, high level weather phenomena to regional aviation weather processors through data links.

Dissemination of aviation weather forecasts and reports to air traffic facilities and aircraft operating agencies will be through regional aviation weather processors. This aviation weather data will be obtained from a central aviation weather processer which will access the AES weather computer for the aviation forecasts. Where feasible, satellite communications channels will be used.

Mass dissemination of aviation weather will continue to be improved through use of appropriate public communication media. More detailed and specific weather information will be provided through DUATs located at flight service stations, flying schools and private or corporate aviation operations centres.

While enroute, pilots will be able to acquire real time weather reports from an increasing number of AWOS and Automatic TWBs equipped with electronic speech generators. Aviation weather information will also be available to aircraft through data links. A dedicated VHF(EWAS) channel will remain available for pilots to communicate directly with the aviation briefing specialist.

FIGURE 5.1. AVIATION WEATHER SYSTEM EVOLUTION



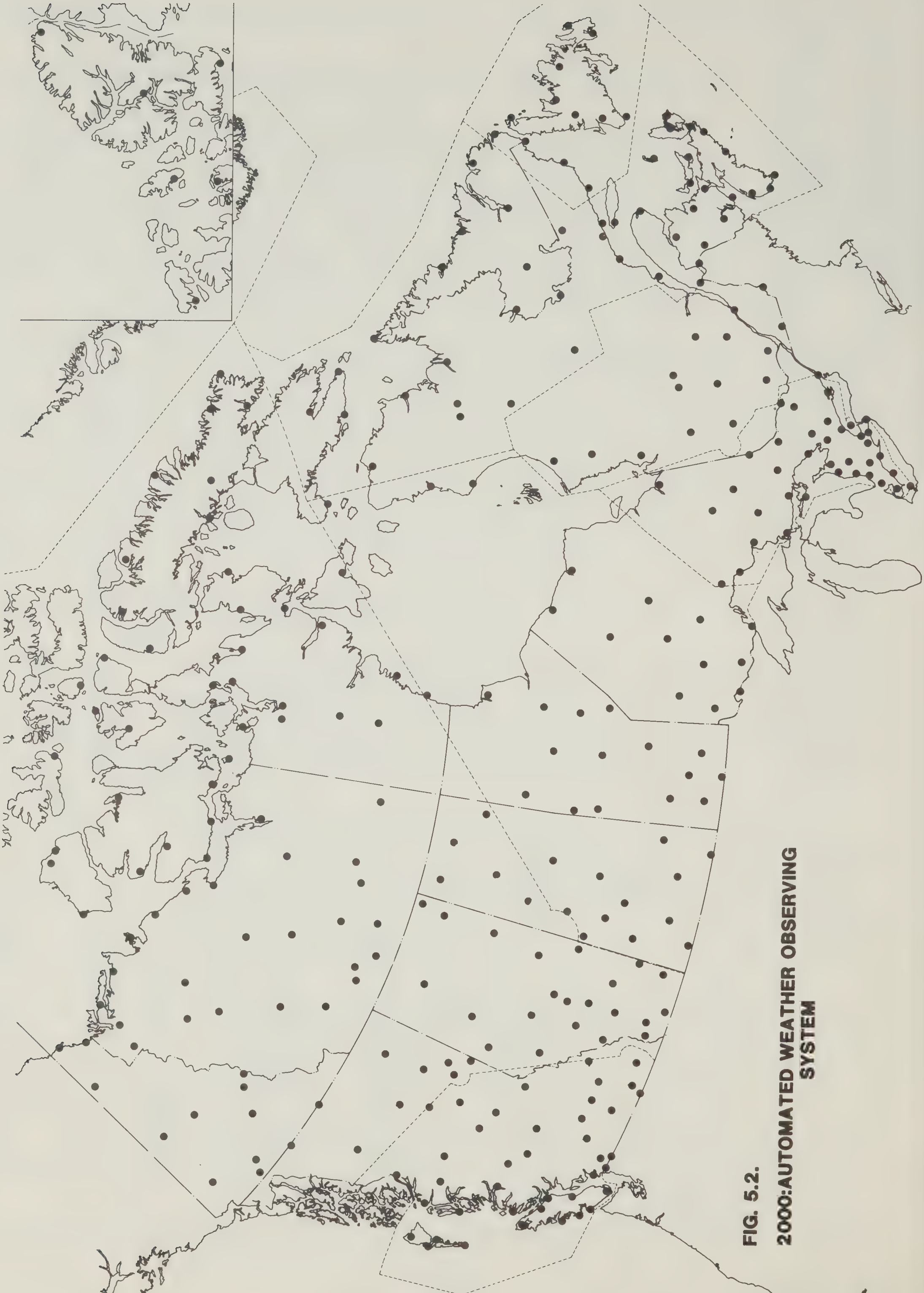


FIG. 5.2.
2000:AUTOMATED WEATHER OBSERVING SYSTEM

5.4 AVIATION WEATHER SYSTEM PROGRAM OF PROJECTS

PROJECT	IMPLEMENTATION	
	1st	Last
<u>AUTOMATION & DISSEMINATION</u>		
1. Aviation Weather Processors	1990	
2. Aviation Weather Mass Dissemination		
(a) Telidon Aviation Briefing System (TABS)	1984	
(b) Weather North	1985	1990
(c) Meteorological Satellite Information System (METSIS)	1986	
(d) Automated Transcribed Weather Broadcast (This project is also 3d in Chapter 4)	1989	1993

PROJECT: 1. AVIATION WEATHER PROCESSORS

PURPOSE: To provide real time and processed weather information for air traffic controllers, flight service specialists and pilots. To provide the weather data base for direct transfer of weather information via data link to aircraft in flight. To provide accurate wind vector profiles for meteorological models used in the FDPS for strategic flight time estimates, conflict prediction and resolution. To serve as interface with AES for collection and distribution of weather products.

Improved availability of weather information for pilots, ATC and FSS personnel will lead to reductions in the large number of weather-related accidents and in air traffic delays caused by weather.

APPROACH: The Aviation Weather Processor will be developed and implemented in an evolutionary manner. The first stage, that is aimed at reducing transmission delays is to carry weather data on the Automatic Data Interchange System (ADIS) network which now has a modern switching centre in Montreal.

This new high speed network will eliminate the need for a separate and costly network such as the existing AES weather network. As the system evolves more powerful Regional processors and specialized software will be added to provide direct user access to all pertinent weather data for flight planning purposes. Processed weather data will be supplied to the FDPS and to FSSs. With the implementation of air-ground data links, weather products will be available in flight.

Sources of data will include AWOS, weather radars, meteorological satellites, AES bulletins and forecasts.

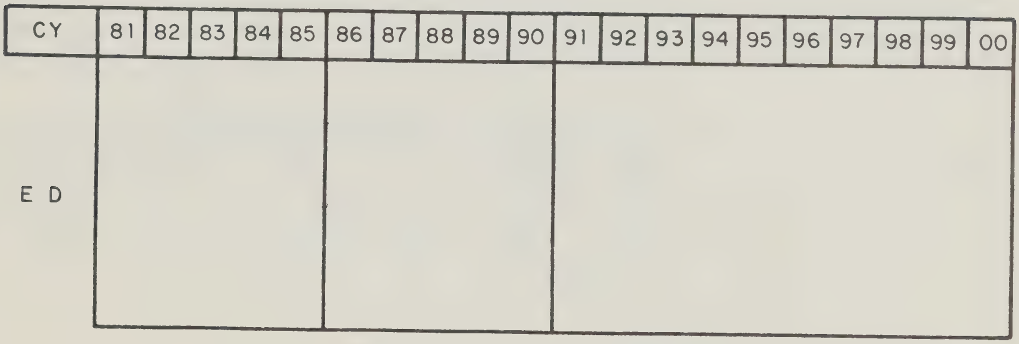
QUANTITIES: Systems will be provided for each of the ACCs, one to TCTI and one to the Technical System Centre.

RELATED PROJECTS/ACTIVITIES:

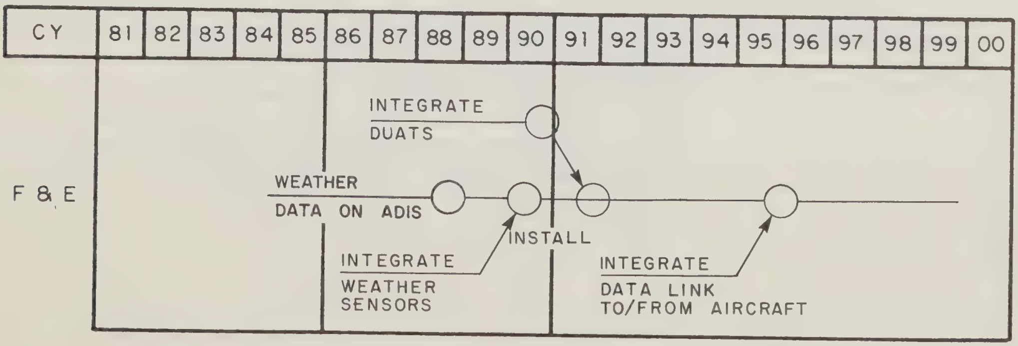
- Flight Data Systems Modernization Project
- Flight Information Services Automation
- Canadian Aeronautical Digital Network
- Radar Modernization Project
- Weather Detection, Processing and Dissemination Systems
- Meteorological Information Display System
- Workstation Ergonomics Studies
- Flight Data Processing Investigations

AVIATION WEATHER PROCESSORS

SCHEDULE



SCHEDULE



PROJECT: 2. AVIATION WEATHER MASS DISSEMINATION

PURPOSE: To enable wide dissemination of aviation weather products to the maximum number of users, including those in remote northern areas.

APPROACH: Several systems and techniques must be employed to distribute weather data because of the variation in the needs and location of the user. Automated systems will be used to the greatest extent possible to ensure wide accessability and timely data. Some existing and proposed systems will be utilized as follows:

a) TELIDON AVIATION BRIEFING SYSTEM (TABS) - This system employs the graphics capabilities of TELIDON to provide weather data such as surface maps, radar depiction and vertical cross-sections. Video terminals, located at busy aerodromes, provide the operator with interactive access to weather and NOTAMs.

b) WEATHER NORTH - An early morning T/V broadcast produced by CBC North and broadcast by satellite to Northern Canada. The program is sponsored by AES and Transport Canada (Air).

c) METEOROLOGICAL SATELLITE INFORMATION SYSTEM (METSIS) - All weather products, including graphics and digital facsimile (DIFAX) will be broadcast via satellite with coverage of all Canada. Although this is an AES program, it is expected that METSIS will be the primary mode of distribution for aviation graphical data.

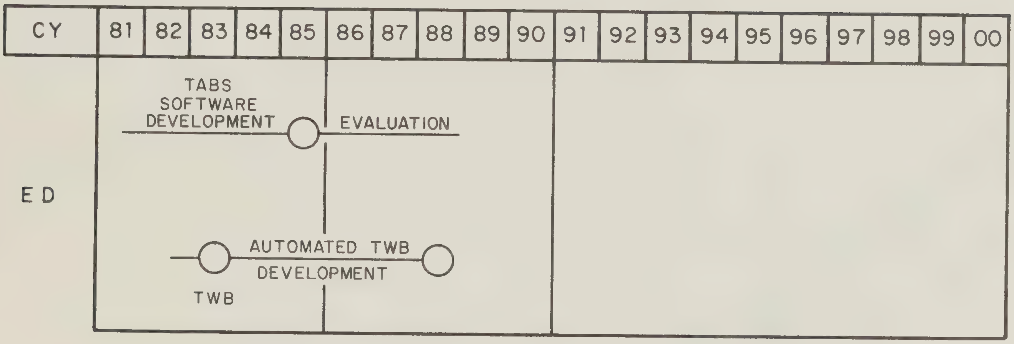
d) AUTOMATED TRANSCRIBED WEATHER BROADCAST (Automated TWB) - An enhancement of the Transcribed Weather Broadcast (TWB) system, the automated system will eliminate the need for human intervention to update the weather data base. Also, voice synthesizers will be used to "broadcast" the data. Radio and telephone access will be provided.

RELATED PROJECTS/ACTIVITIES:

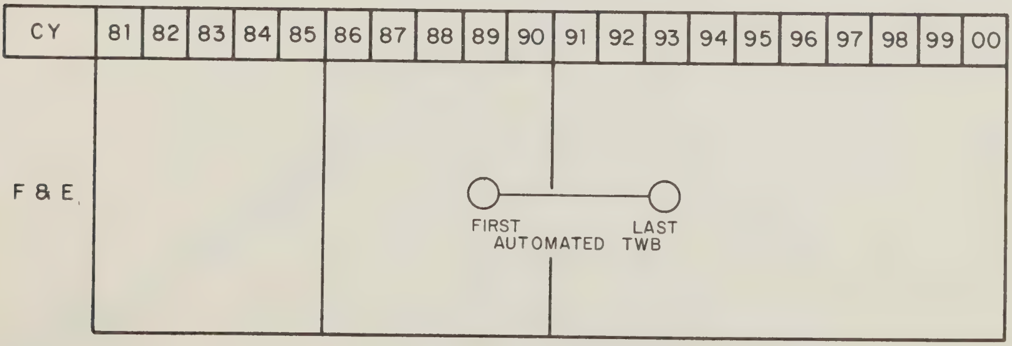
- Meteorological Information Display System
- Aviation Weather Processors
- Flight Data Systems Modernization Project
- Flight Information Services Automation
- Speech Processing and Transmission Systems Development
- Weather Detection, Processing and Dissemination Systems
- Telecommunications Networks Investigations
- Canadian Aeronautical Digital Network

MASS DISSEMINATION OF AVIATION WEATHER

SCHEDULE



SCHEDULE



CHAPTER 6

GROUND TO AIR SYSTEM

GROUND TO AIR SYSTEMS

CONTENTS

ILLUSTRATIONS

CHAPTER 6

GROUND TO AIR SYSTEM

6.1 GENERAL

The ground-to-air system comprises communication, navigation and surveillance systems. Communication systems provide radio links between pilots and air traffic controllers or flight service specialists. Navigation systems provide guidance to aircraft while surveillance systems provide aircraft position information to air traffic controllers at ACCs, TCUs and Towers.

6.2 COMMUNICATIONS

Ground-to-air communications facilities provide voice radio communications between controllers and pilots in both enroute and terminal airspace. Other ground-to-air facilities provide communication between pilots and flight service specialists.

Ground-air VHF and UHF communications stations, both local and remote, are located to give coverage for each air traffic control sector, as well as for FSS communications. Between 90 and 95 percent of the existing communications transmitters and receivers use solid state technology and the remainder are being replaced through ongoing programs. UHF equipment is currently fully solid state. VHF equipment has been converted to 25 kHz spacing for use in the airspace above 18,000 ft. Conversion to 25 kHz channel spacing for low level airways and terminal areas will be implemented where frequency congestion occurs.

Long-range HF facilities are used to communicate with international flights over oceanic areas and in Northern Canada where it has not yet been economical or possible to provide complete VHF coverage. Generally, all the HF transmitters associated with international operations are modern but the receivers are old and will be replaced. The HF transmitters and receivers associated with domestic operations are also scheduled for replacement.

6.3 NAVIGATION

The navigation systems can be broadly divided between those which provide enroute guidance and those which provide approach and landing guidance although some are used for both purposes if they are suitably located.

The present route structure for the navigation of air traffic is based both on navigation and air traffic control requirements and is characterized by the strategic placement of VHF

Omni-Ranges (VOR) and/or Non- Directional Beacons (NDB) for the delineation of airways (controlled airspace) and air routes (uncontrolled airspace). The VOR may be colocated with either Distance Measuring Equipment (DME) or military Tactical Air Navigation Systems (TACAN). Azimuth guidance is provided by the VOR while distance to the VOR is provided by either the DME or the TACAN. NDB's utilized in the enroute system are of high power (above 100 watts).

The main disadvantage of the airway and air route method of navigation, at least for the longer range flights, is the lack of flexibility in routing. Some aircraft, equipped with area navigation systems, are capable of navigating on any desired track within the coverage of station-referenced navigation aids or within the limits of a self contained navigation system. This allows more direct and fuel-efficient routing through the system, which is limited at present by the requirements of the ATC system.

Long range ground based navigational systems such as Omega and Loran C are not currently considered as an integral part of the present system. They are, however, becoming more widely used in areas where coverage is available and for special applications.

The present airport approach and landing systems can be divided into two categories; non-precision and precision. The non-precision system is comprised of low power NDB's, VOR's and stand alone localizers (LOC) which in some cases are supplemented with DME (LOC/DME). The precision system consists of the ICAO standard Instrument Landing System (ILS). The precision system uses both elevation and azimuth guidance from the ground facility as well as marker beacons and locator NDB's and in some cases DME. The non-precision approach uses only azimuth guidance and as a result such approaches permit landings only under higher weather minima than the precision system.

Of the present enroute and approach and landing navigation equipment, about 75% has been upgraded to solid state technology. Remote maintenance monitoring such as might be achieved by microprocessor control is not currently a feature.

The VHF Direction Finder (VHF/DF) is used to guide pilots who are lost or uncertain of their position and for other emergencies. The aircraft's bearing is determined from the ground station using the aircraft's radio transmissions and used by ATC and FSS to provide verbal guidance to the pilot. All of the present VHF-DF equipment is solid state.

The Runway Visual Range (RVR) is a computed visibility value representing the minimum expected distance a pilot would be able to see along the runway based on his sighting of runway markers or lights at prevailing intensity settings. The RVR system is comprised of the transmissometer and the RVR computer

computer. The transmissometer is located adjacent to the runway to measure ambient transmissivity while the RVR computer converts the transmissometer output into visibility in units of feet. At ACC's the Operational Information Display System (OIDS) performs the functions of the RVR computer. The RVR systems currently in use employ vacuum tube technology.

6.4 SURVEILLANCE

Density of air traffic is one of the major factors considered in determining the type of surveillance system used for air traffic control. Within Canadian airspace, surveillance in the high density traffic area (mainly over southern Canada) is provided by radar systems of which there are two types: Primary Surveillance Radar (PSR) and Secondary Surveillance Radar (SSR). In the low density traffic area (mainly over Northern Canada) and in the Oceanic area, surveillance is effected through the use of pilot position reports.

The position of targets (aircraft) and the location of weather in the PSR system is determined by measuring and displaying reflected signals (RF energy). The SSR system relies on reply signals transmitted from airborne electronic equipment called transponders. On aircraft equipped with altitude encoders, the transponder automatically transmits the aircraft's altitude. The SSR system is currently the main source of radar surveillance information used for ATC in both the enroute and terminal environments. Because SSR systems are unable to detect weather, PSR systems supplement SSR and give limited weather information. As well, PSR systems enable the detection of aircraft not equipped with transponders. Radar surveillance installations are comprised of either colocated PSR and SSR systems, or stand-alone SSR systems.

A number of the SSR systems of the Department of National Defence are also used by Transport Canada (as stand-alone SSR) to supplement enroute coverage.

At specific airports, where traffic warrants, surveillance of surface traffic is also provided. This Airport Surface Detection Equipment (ASDE) is used by tower controllers to monitor the position of aircraft and vehicles on the manoeuvering area of the airport (runways and taxiways) particularly during conditions of reduced visibility.

At present, Atmospheric Environment Services of Environment Canada (AES) owns and operates a number of C band weather radars. These systems are situated in the more populated areas of the country. The aviation community is but one of the many users of data derived from these systems.

The ATC radar surveillance equipment is antiquated and uses, for the most part, vacuum tube technology. Remote maintenance monitoring is not a feature of the present system.

6.5 THE NEW APPROACH

Conversion of ground-to-air systems to fully solid state design will continue; increased emphasis will be placed on implementation of remote maintenance monitoring for all systems; consolidation of communication, navigation and surveillance locations will be emphasized to reduce maintenance costs. New and more capable systems will be implemented such as Mode S with data link and the Microwave Landing System (MLS). Satellite/HF data link and supplementing Omega by VLF stations will be further studied and implemented as appropriate. Dependent surveillance will be implemented whereby on-board navigation systems will provide air traffic control with automatic position data via HF/satellite data link.

To develop a nationwide integrated system of communications, navigation and surveillance, including weather radar coverage, the concept of networking will be used. These networks will result in significant improvements in availability of service and system back-up capability, ensuring full use of the coverage provided by these systems.

Navigation systems development will see minimal expansion of the VOR-DME network which will ensure that navigational coverage is consistent with the coverage provided by surveillance radars in the high density traffic area. Similar coverage from communications systems will be available. Increased use of Omega will be encouraged by supplementing coverage with one or two VLF stations. The concept of required navigation performance capability for operations at and above 18,000 ft. in the low density traffic area will be adopted. Installation of VOR-DME in the low density traffic area will be considered where traffic and operational considerations justify the requirement.

Navigation Satellites or Global Positioning Systems (GPS) such as NAVSTAR and NAVSAT are presently being developed and will be used by the international aviation community. They will provide accurate three-dimensional positioning even where coverage by present surface facilities is impossible or impractical. Indications are that airborne equipment to use these systems will become inexpensive and readily accessible by general aviation. International efforts will be monitored and systems evaluated to adopt GPS use in Canadian airspace.

Landing systems development will see the complete replacement of the ILS by the new ICAO standard MLS by the end of the period and the implementation of category III operations at a small number of the busier airports. The withdrawal of ILS could commence as early as January 1st 1995 but it is currently planned to withdraw between 1998 and 2000. Existing non-precision approach systems will continue to be utilized and

6.5 THE NEW APPROACH Cont'd

utilized and will be supplemented by DME at selected locations. As ILS is withdrawn from service the locator NDB's will be retained, where required, to preserve the non-precision approach on that runway.

Surveillance systems development will see the replacement of all existing radar systems, both primary and secondary, and the incorporation of Mode S in the enroute secondary surveillance radars. Secondary Surveillance radar data obtained from FAA radars will be integrated into the surveillance network. The weather surveillance data provided by the primary ATC radars will be combined with dedicated weather radar data to improve the real time weather picture for pilots, controllers and flight service specialists. Total coverage by these systems will be provided in the high density traffic area at and above 18,000 ft. and in critical areas at and above 12,500 ft. Coverage will also be available within terminal control areas. In low density traffic areas, at and above 18,000 ft, surveillance will be provided by relaying airborne derived navigational information via an HF/satellite data link.

6.6 EVOLUTION OF THE SYSTEM

CURRENT PROGRESS (TO 1985)

Communications improvements have been focussed on replacing obsolete vacuum tube type equipment with solid-state equipment. Additional communication facilities are being provided, particularly in northern areas. Application of remote maintenance monitoring techniques to some of the more isolated communication facilities was commenced during this period. Conversion of communications equipment to 25 kHz channel spacing capability has been completed where required.

Conversion of VOR systems to solid state technology has continued and will be completed by 1990. Plans for retrofitting existing installations with automatic ground checking and remote maintenance monitoring have been finalized. Plans have also been finalized with DND for the TACAN modernization program, to be completed by 1990. The Enroute NDB modernization program has continued at a rate of approximately 20 per year in order to complete the program by 1988. Conversion to voice identification and incorporation of continuous broadcasting of weather information on NDB's is being investigated. The development and engineering work for remote maintenance monitoring for NDB's has begun.

During this period, to expand enroute coverage, approximately 9 VOR/DME's, 3 VHF/DF's and 20 NDB's have been installed. Plans for expansion, consolidation and relocation of navigation and communications facilities beyond 1985 have been formulated, based on the need to cater to area navigation requirements and reduced maintenance.

6.6 EVOLUTION OF THE SYSTEM Cont'd

For the low density traffic area, VLF coverage to supplement Omega has been further studied in order to finalize the technical requirements for these systems and to establish an appropriate implementation plan. As a result of other studies no new Loran C installations are contemplated.

The conversion of non-precision approach equipment to solid state has continued. No change in the type of systems in use have been made. Expansion of NDB installations has continued at a rate of about 5 per year. Five new LOC/DME systems have been installed. VOR/DME installations are not carried out specifically for the purpose of an instrument approach aid although some new enroute VOR/DME's may be dual purpose.

Replacement of all but 13 aging tube type ILS installations with solid state equipment has been completed and plans have been developed to replace the remainder and provide 8 new ILS installations by 1987.

An engineering test MLS system has been installed and is being used for development of technical and operational standards and procedures. An additional two systems are planned to support the STOL operation between Toronto, Montreal and Ottawa. A Plan for the transition from ILS to MLS will be completed. Developmental work is being carried out on Precision DME (DME-P) equipment and procurement of a test DME-P system is underway.

The RVR transmissometers are being replaced with solid state units and modernization of the RVR computers and displays has begun. New installations incorporate the new designs for the transmissometers and the computer and associated displays.

Most of the radar surveillance modifications and improvements have concentrated on stabilizing the performance of the aging sensors, using stop gap measures and off-the-shelf components, until their replacement under the Radar Modernization Project (RAMP).

Interim improvements to the existing surveillance radar systems were made by installing open-array antennae at sites with serious SSR reflection problems. Primary radar modifications (such as the Programmable Geographic Attenuator (PGA) and replacement RF amplifiers) were developed and implemented.

Six new solid state ASDE radars have been purchased and installation of these systems will be completed by 1989. Pearson International Airport is in the process of replacing its original ASDE with the first of the new systems.

There are now fourteen weather radars, owned by AES, which provide radar derived weather information for aviation purposes. An additional radar, operated by McGill University, supplies weather data to the Montreal Airport briefing office. Four of the present AES weather radars have been replaced by new solid state equipment. Investigations have commenced into the possible use of data from FAA new weather radars (NEXRAD).

NEAR TERM (TO 1990)

VHF and HF communication facilities will be converted to solid-state. Total VHF communication coverage at 12,500 feet and above in the high density traffic area will be completed. Consolidation of compatible communications navigation and radar equipment into common buildings will be carried out where cost savings and improved reliability can be achieved.

Engineering development work will be carried out to establish and test the satellite/HF data link system which will provide surveillance capability within the low density traffic area. Coordination will be carried out with industry and interested countries to ensure the compatibility of the proposed system with Mode S data link and to bring suitable airborne interface equipment onto the market.

Conversion of all ground based enroute navigation systems to solid state technology will be completed and implementation of remote maintenance monitoring for these facilities will be near completion. Expansion of VOR/DME coverage within the high density traffic area will allow for area navigation at or above 18,000 ft. Studies will continue to determine if VLF coverage should be implemented to supplement Omega in North and Central Canada. During this period a limited mix of aids such as VOR, DME, NDB, VLF, VHF/DF will be installed if they can be justified on cost/benefit analysis.

Engineering investigations will be undertaken to evaluate GPS as a navigation system for use in Canadian airspace. Development projects will be conducted jointly with the Federal Aviation Administration in the U.S. Specifications will be developed for facilities to meet the operational requirements of the Air Navigation System.

Due to the commencement of MLS installations in 1989 installation of the new and replacement ILS's will terminate by the year 1987. During the period remote maintenance monitoring will be integrated into existing ILS installations while the new MLS installations will include remote maintenance monitoring at the time of installation. DME-P will be incorporated into MLS installations and by 1990 all existing and future MLS will include DME-P. Existing DME's at ILS installations will be replaced by DME-P to release the higher power DME equipment for use as enroute facilites. Existing RVR computers will be upgraded complete with remote maintenance monitoring and solid state displays. Development work will be carried out in the area of sensor stabilization and alternative light sources.

6.6 EVOLUTION OF THE SYSTEM Cont'd

The Radar Modernization Project (RAMP) will upgrade the present radar systems with new solid-state, primary and secondary surveillance radar systems. The new Primary Surveillance Radar (PSR) will employ advanced signal processing, permitting improved target and weather detection. The Secondary Surveillance Radar (SSR) system will employ monopulse techniques for greater positional accuracy and will be upgradable to SSR Mode S operation. SSR Mode S upgrade development will begin.

PSR, which will be installed at qualifying airports, will provide aircraft surveillance coverage out to 80 nm. Colocated SSRs will provide coverage out to 250 nm and up to 70,000 feet. Full SSR coverage will be provided at 18,000 feet and above throughout the high density traffic area, through the utilization of additional stand alone SSRs. Hazardous weather will be detected by the PSR out to 100 nm. Remoting of digital radar data will provide surveillance and weather information to the appropriate Air Traffic Services facilities.

Following the installation of the first of the new, solid state ASDE radar systems at Pearson International in 1986, the remaining operational systems will be installed at Vancouver in 1986, Dorval in 1987, Ottawa and Calgary in 1988 and at Winnipeg in 1989. A training system will also be provided in 1986/87. The need for providing target identification tags on the ASDE displays will be reviewed.

AES radar derived weather data, combined with satellite-derived weather data will be provided to ATS through increased use of digital remoting of data. A basic level of ATS meteorological processing will provide directly interpretable weather information.

LONG TERM (TO 2000)

Dependent surveillance capability, the airborne derived navigational data transmitted to ATS via an HF/Satellite data link, will be available. Ground-based facilities will be developed to support GPS in Canadian airspace.

The installation of additional VLF/NAV stations will provide improvements in low level navigation capability.

ILS systems will be decommissioned over the period 1998 to 2000. MLS installations will be carried out beginning in 1989 so that there will be approximately 141 in place by 2000. Consideration will also be given to installing the azimuth portion of the MLS for track guidance purposes where justified.

6.6 EVOLUTION OF THE SYSTEM

LONG TERM (TO 2000) Cont'd

Category III MLS will be installed, where justified, at qualifying airports. Development work on a new precision surface navigation system will be carried out prior to the implementation of CAT III.

The monopulse SSR radars will be upgraded to provide continuous Mode S data link coverage above an altitude of 18,000 ft. (12,500 ft. in critical areas) and down to the surface at qualifying airports in the high density traffic area. To obtain automated air traffic control clearance aircraft will have to be equipped with Mode S transponders. This will improve the ATC systems capability of providing separation assurance and increase air traffic control flexibility and efficiency. An automatic aviation weather response system will be available to pilots by data link. ATC messages will be transmitted by data link to the cockpit.

Improved weather detection will result from adding to and upgrading the weather radar network. This network will ensure weather radar coverage above 18,000 feet throughout the high density traffic area.

Additional ASDE systems will be provided for qualifying airports. Display systems for the airport traffic will include the capability to display aircraft identification tags.

Surveillance in the low density traffic area and in the oceanic area will be provided through dependent surveillance techniques. In these areas, on-board navigation equipment will provide positional data to ATS facilities via HF/satellite data links.

Engineering development work will be carried out during this period to establish the potential of satellites to provide communications, navigation and surveillance.

FIGURE 6.1. COMMUNICATIONS SYSTEMS EVOLUTION

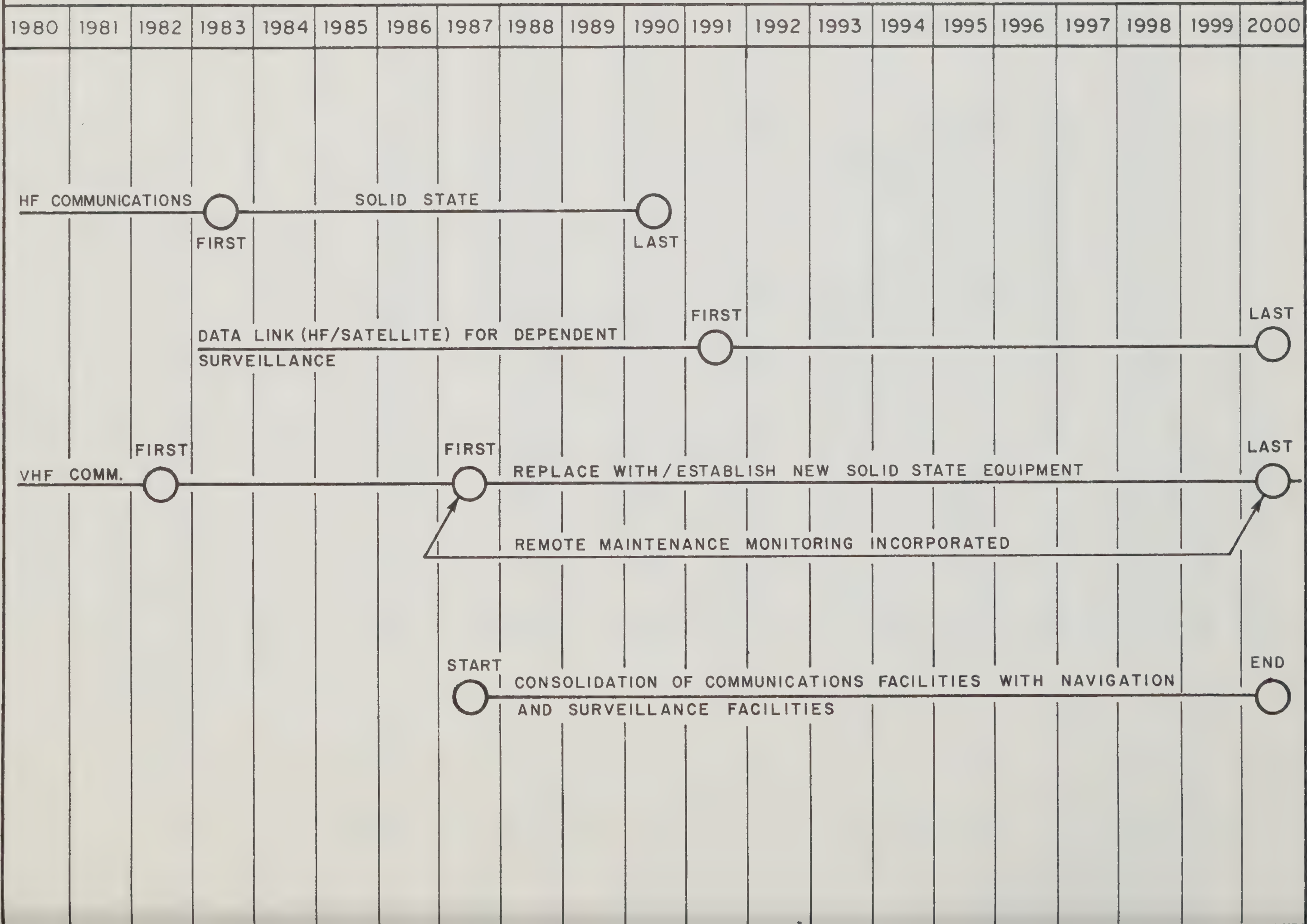
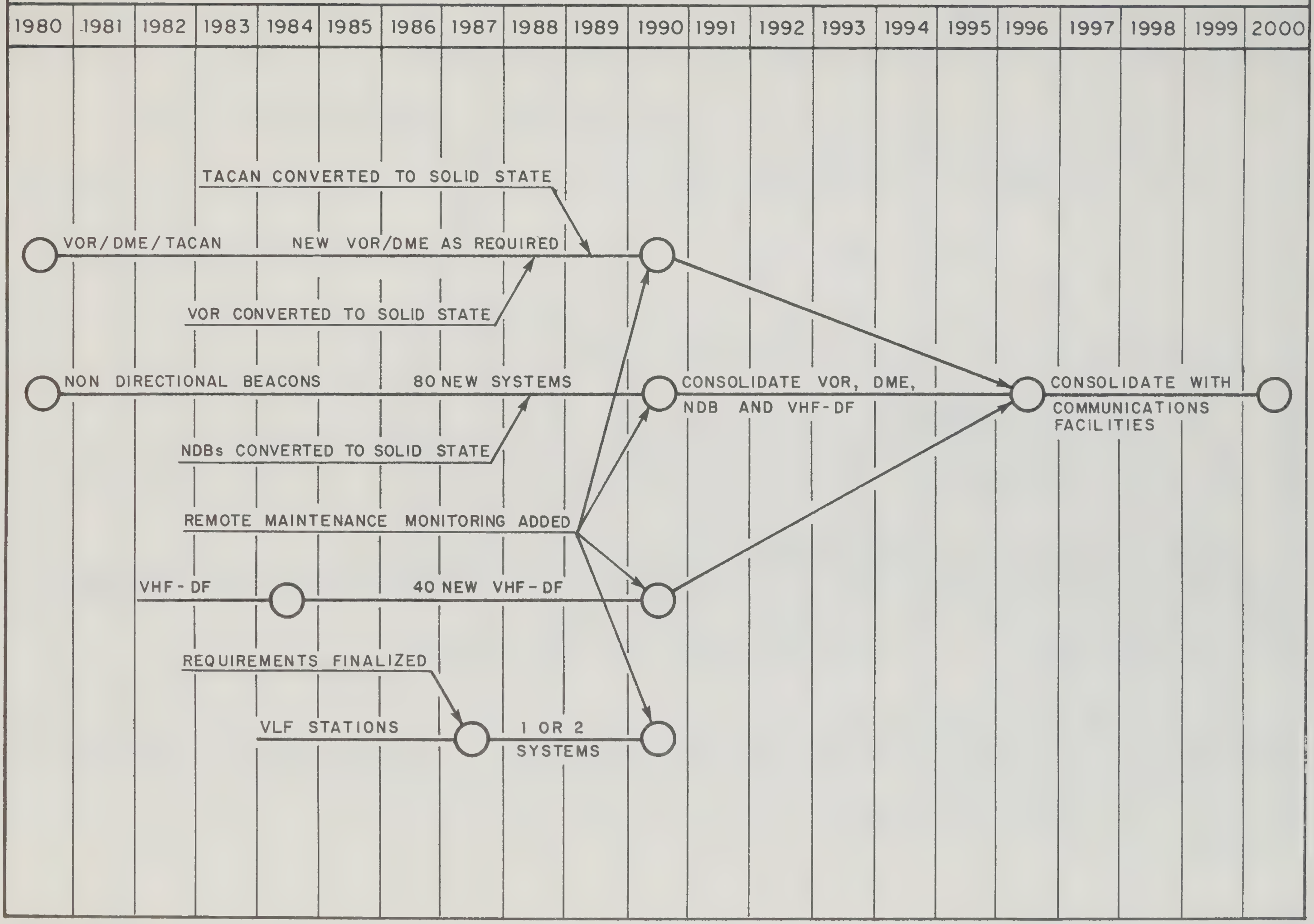


FIGURE 6.2. NAVIGATION SYSTEMS EVOLUTION



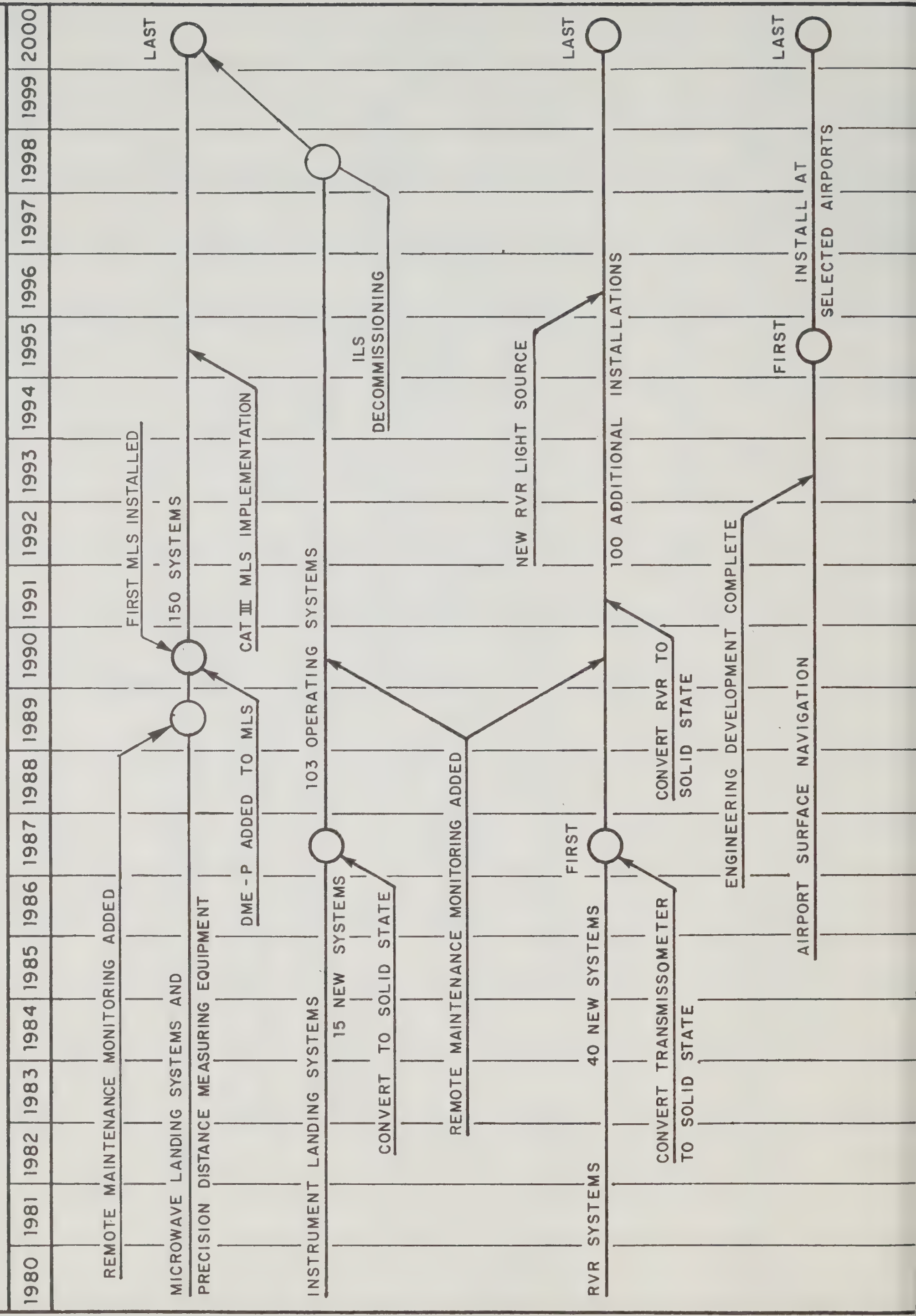
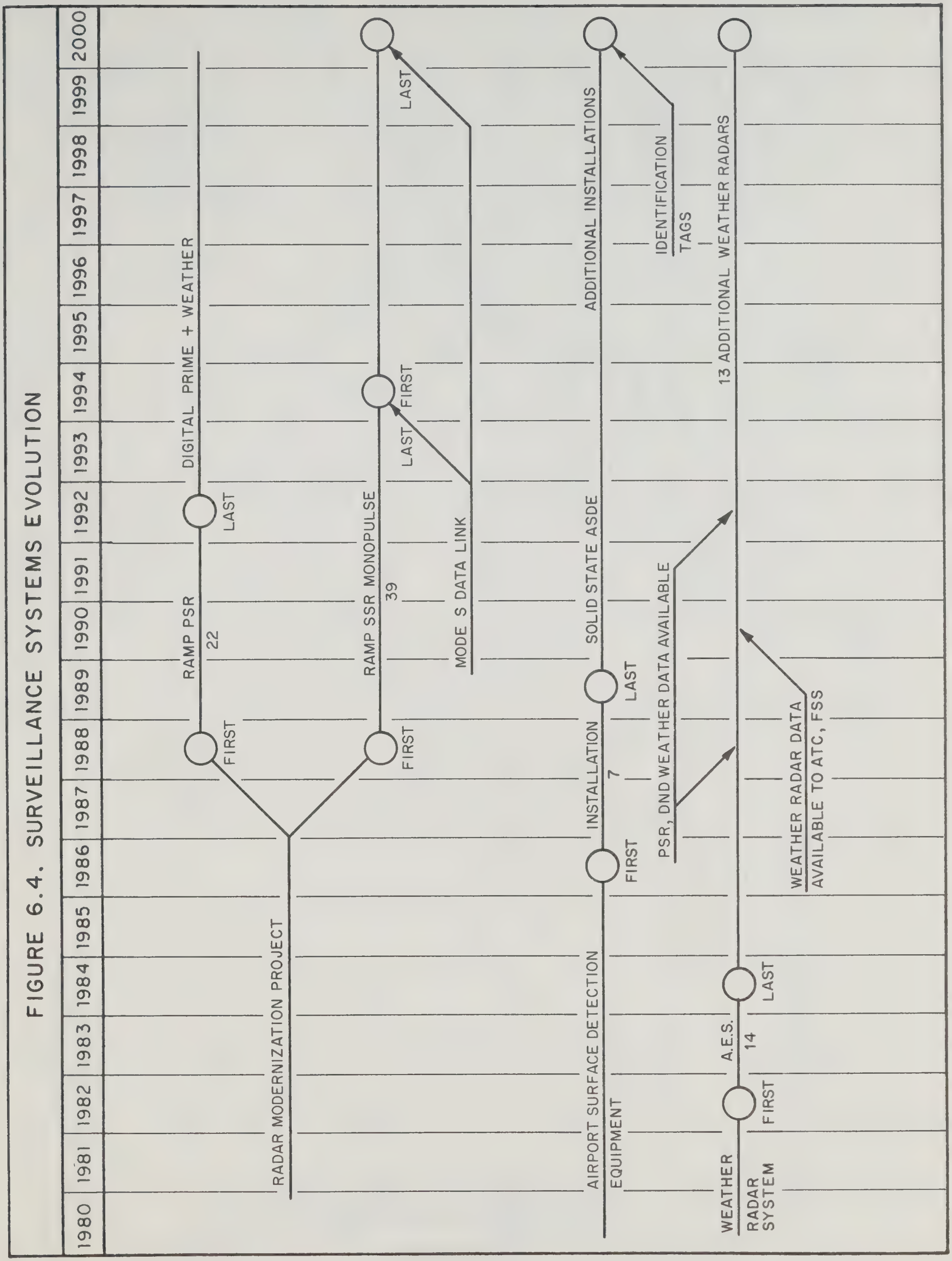


FIGURE 6.3. APPROACH AND LANDING SYSTEMS EVOLUTION

FIGURE 6.4. SURVEILLANCE SYSTEMS EVOLUTION



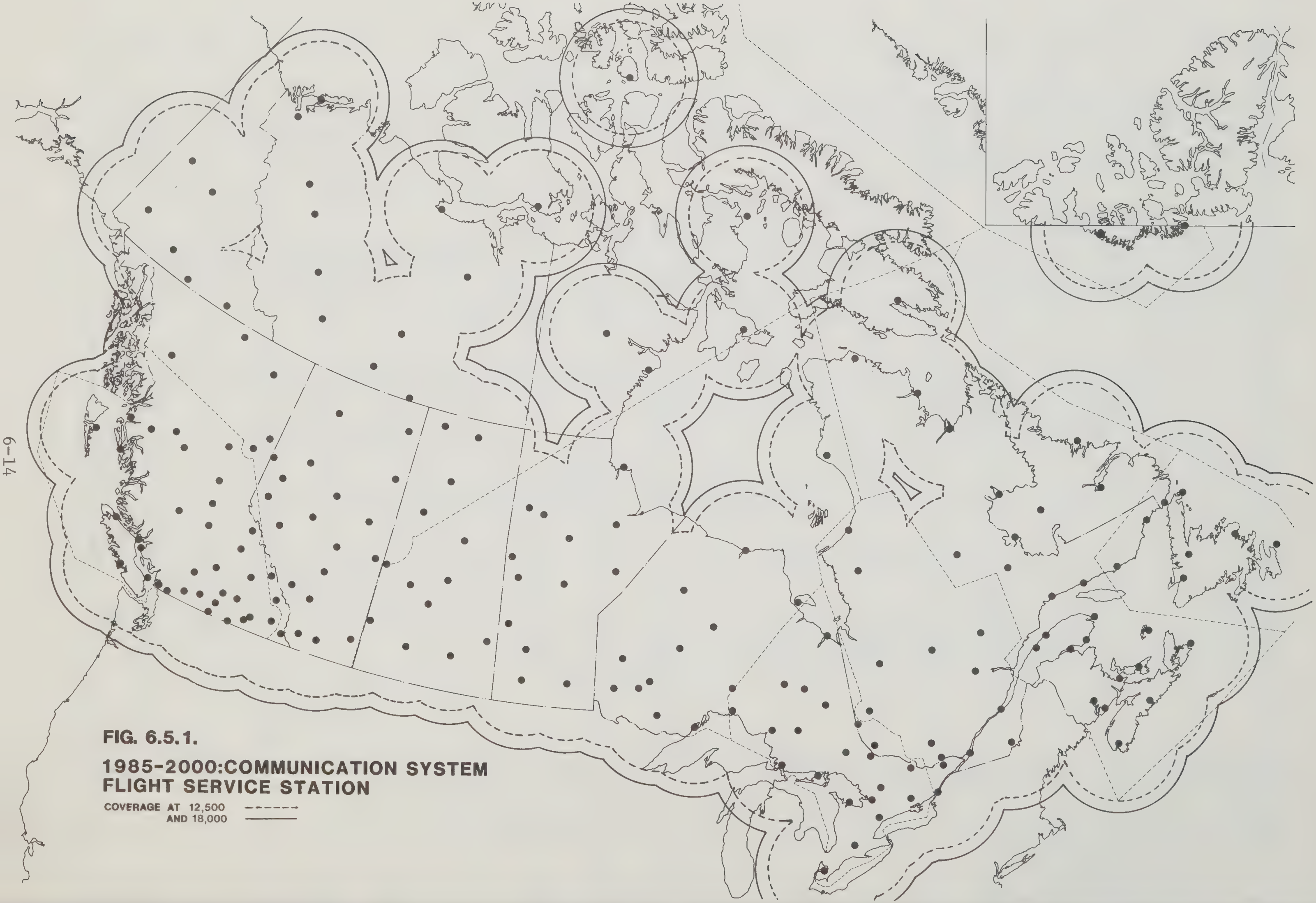


FIG. 6.5.1.

1985-2000:COMMUNICATION SYSTEM
FLIGHT SERVICE STATION

COVERAGE AT 12,500 - - - - -
AND 18,000 ———

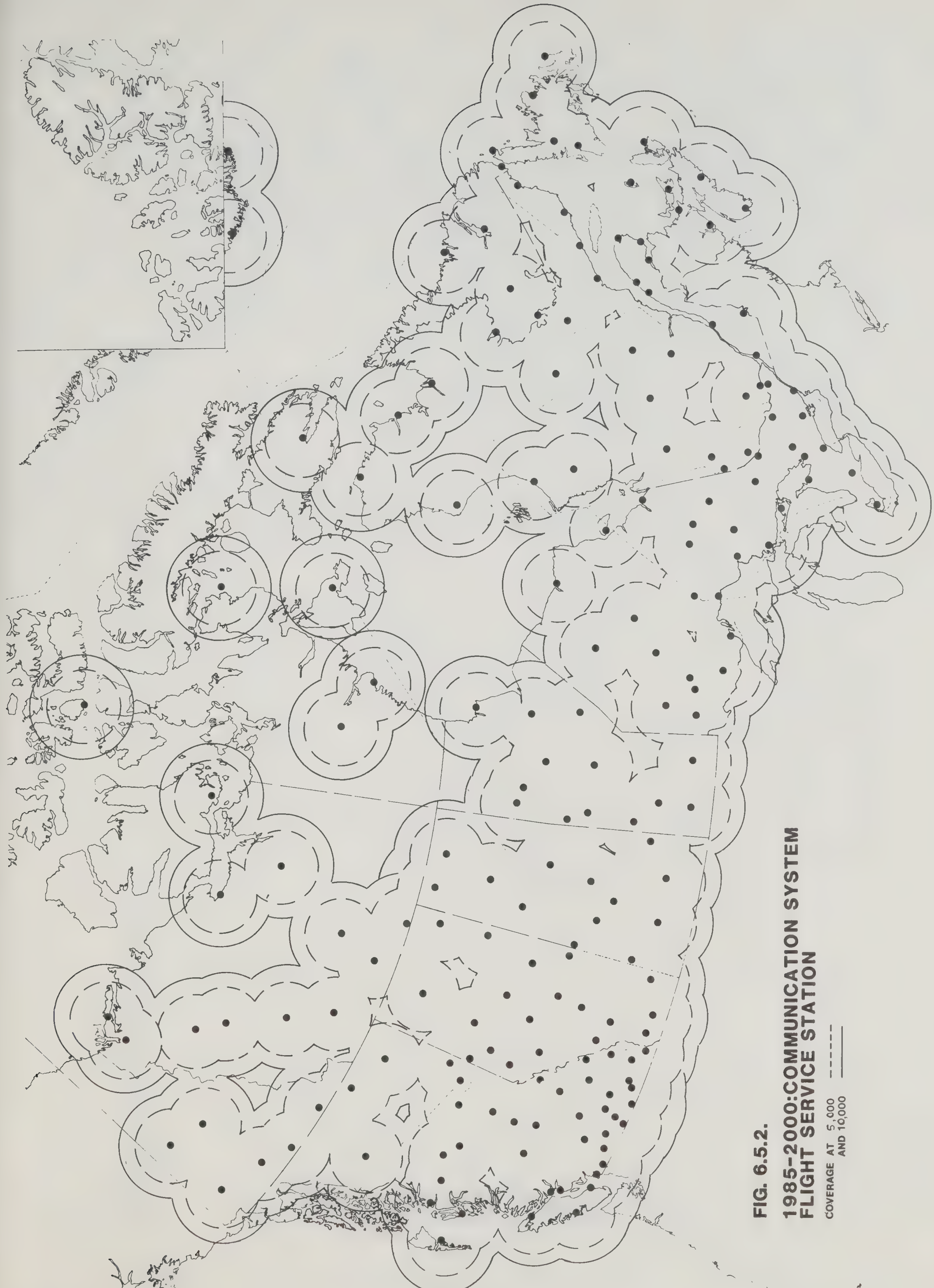


FIG. 6.5.2.

1985-2000:COMMUNICATION SYSTEM FLIGHT SERVICE STATION

COVERAGE AT 5,000 ------
AND 10,000 ——

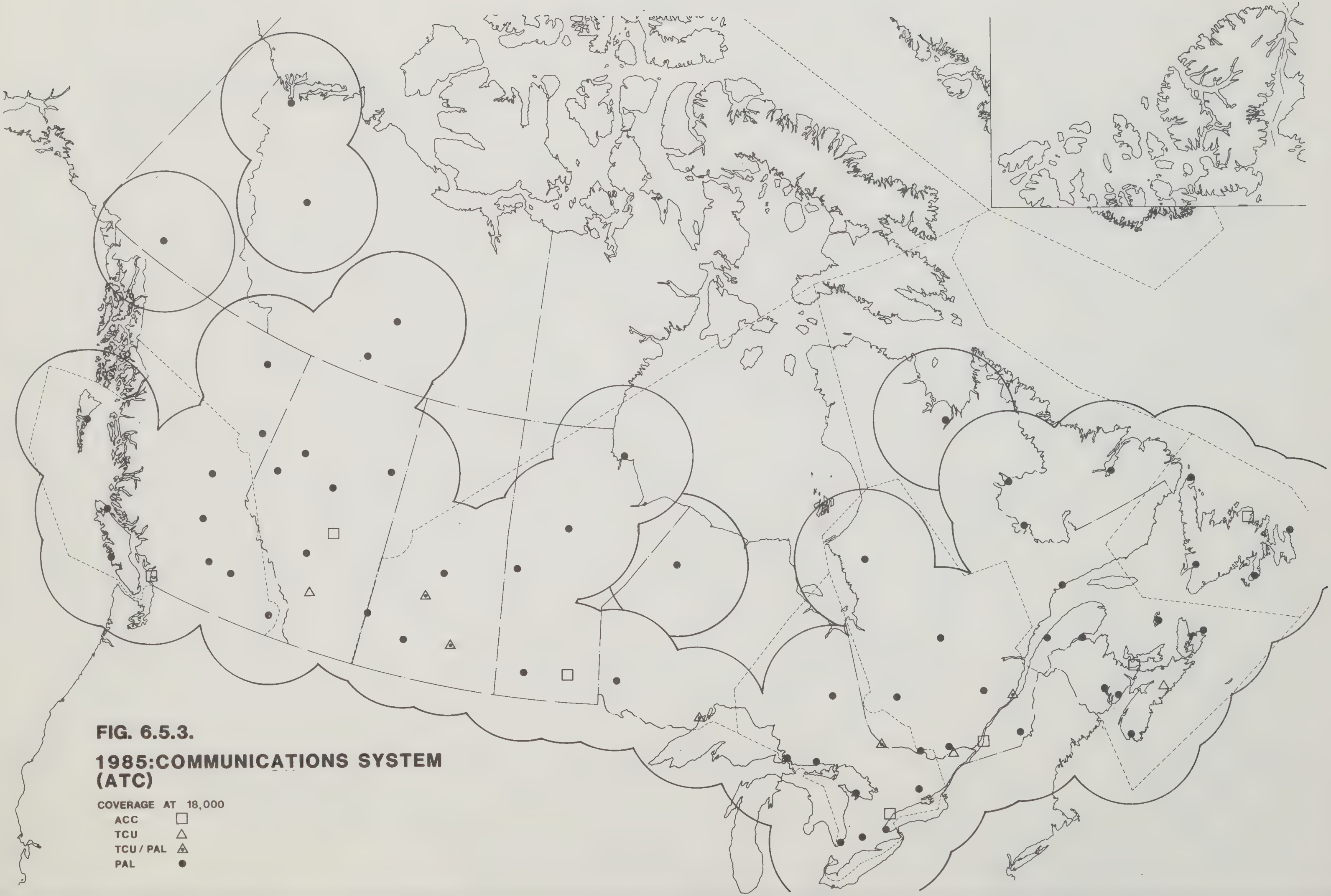


FIG. 6.5.3.

1985:COMMUNICATIONS SYSTEM (ATC)

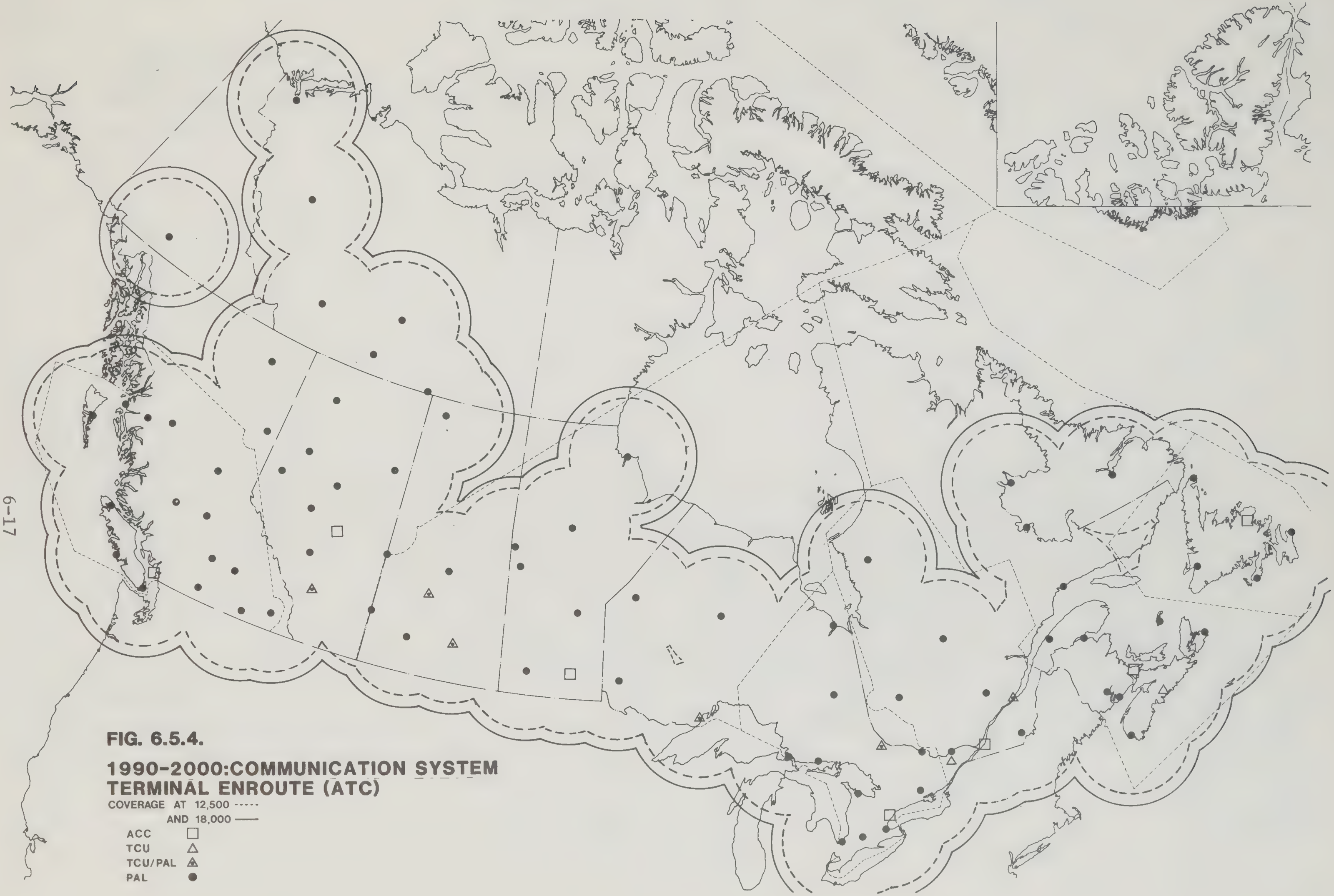


FIG. 6.5.4.

1990-2000:COMMUNICATION SYSTEM TERMINAL ENROUTE (ATC)

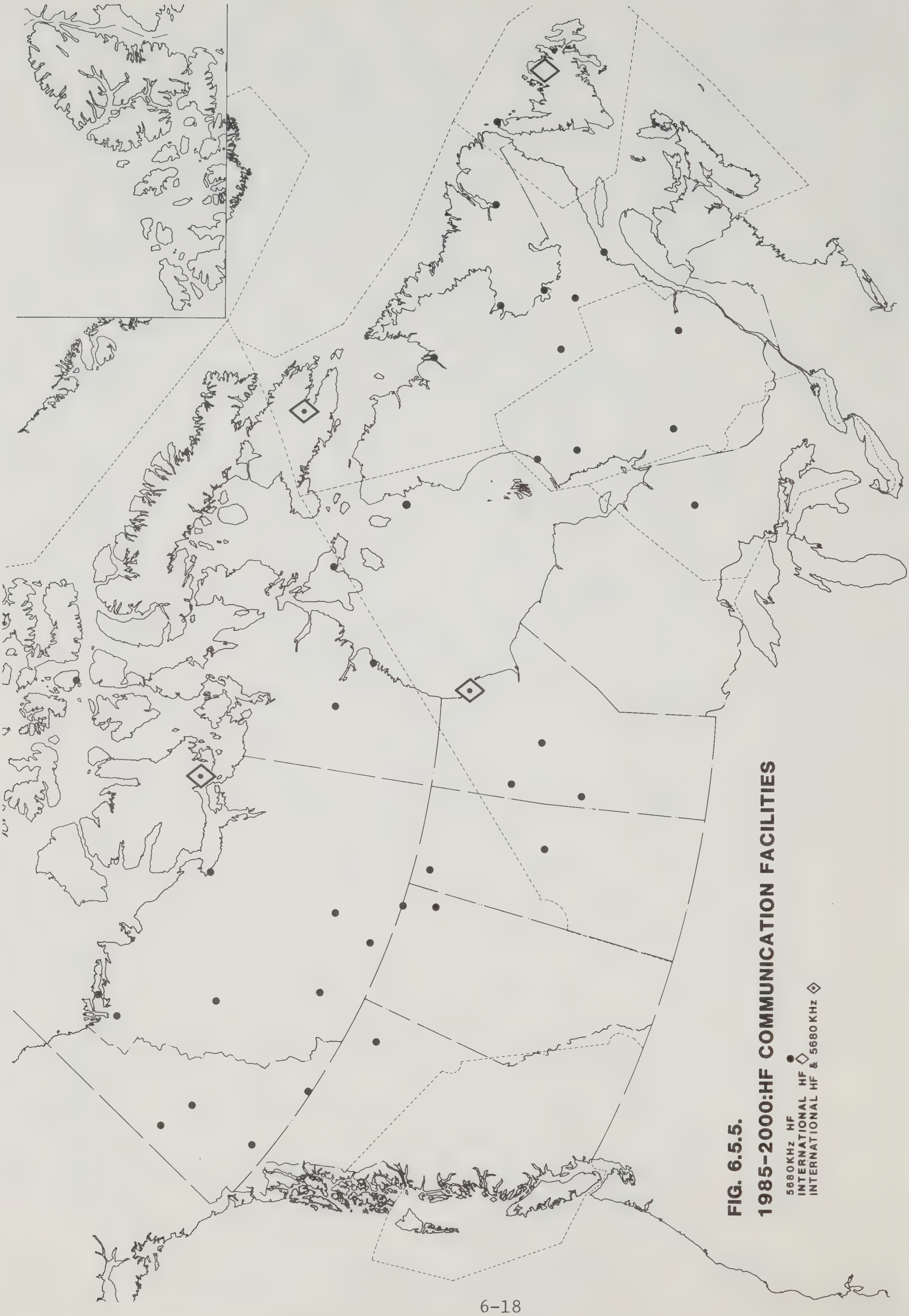


FIG. 6.5.5.
1985–2000:HF COMMUNICATION FACILITIES

FIG. 6.6.1.
1985:VOR-DME SYSTEM
COVERAGE AT 18000 FEET

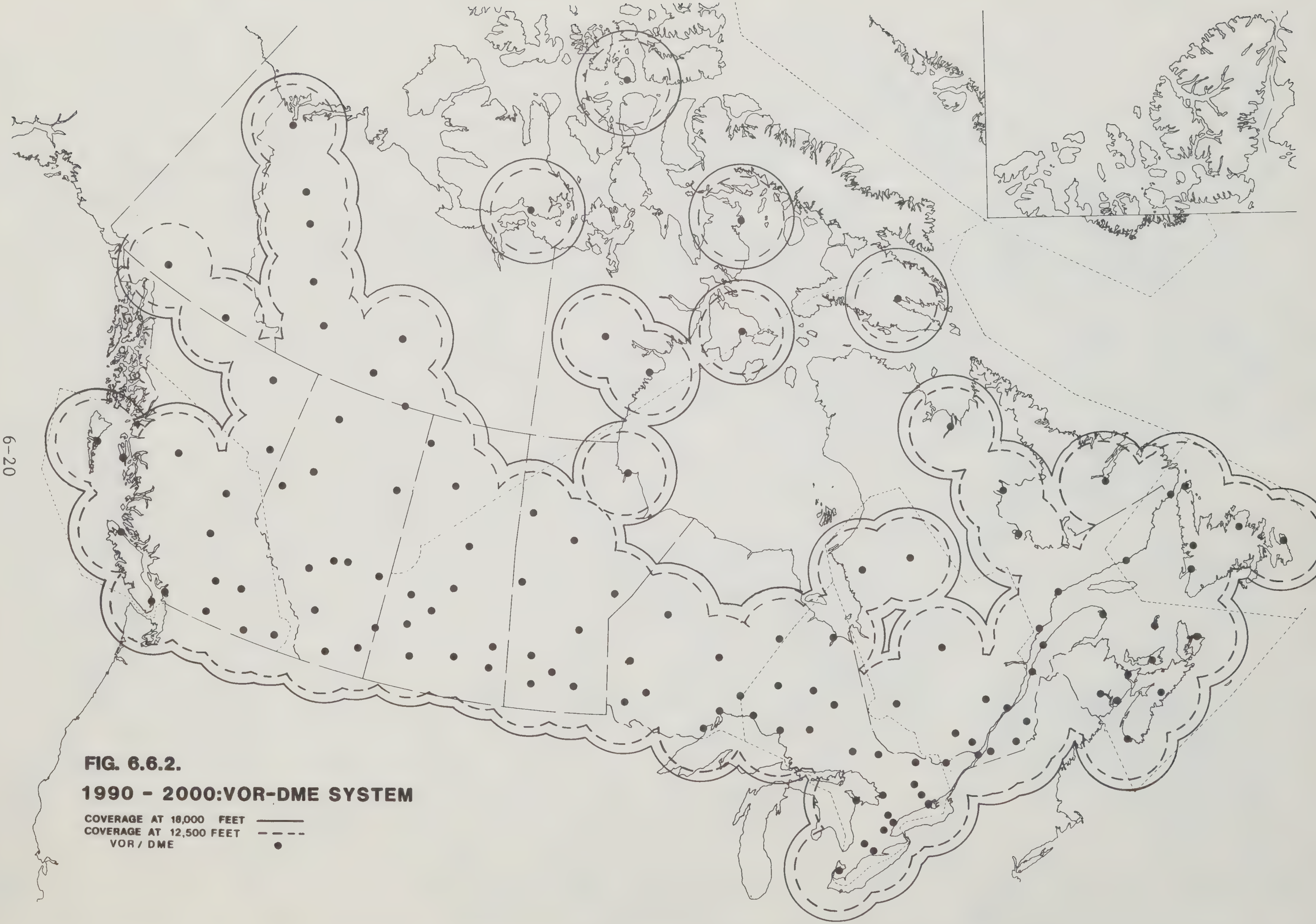


FIG. 6.6.2.

1990 - 2000:VOR-DME SYSTEM

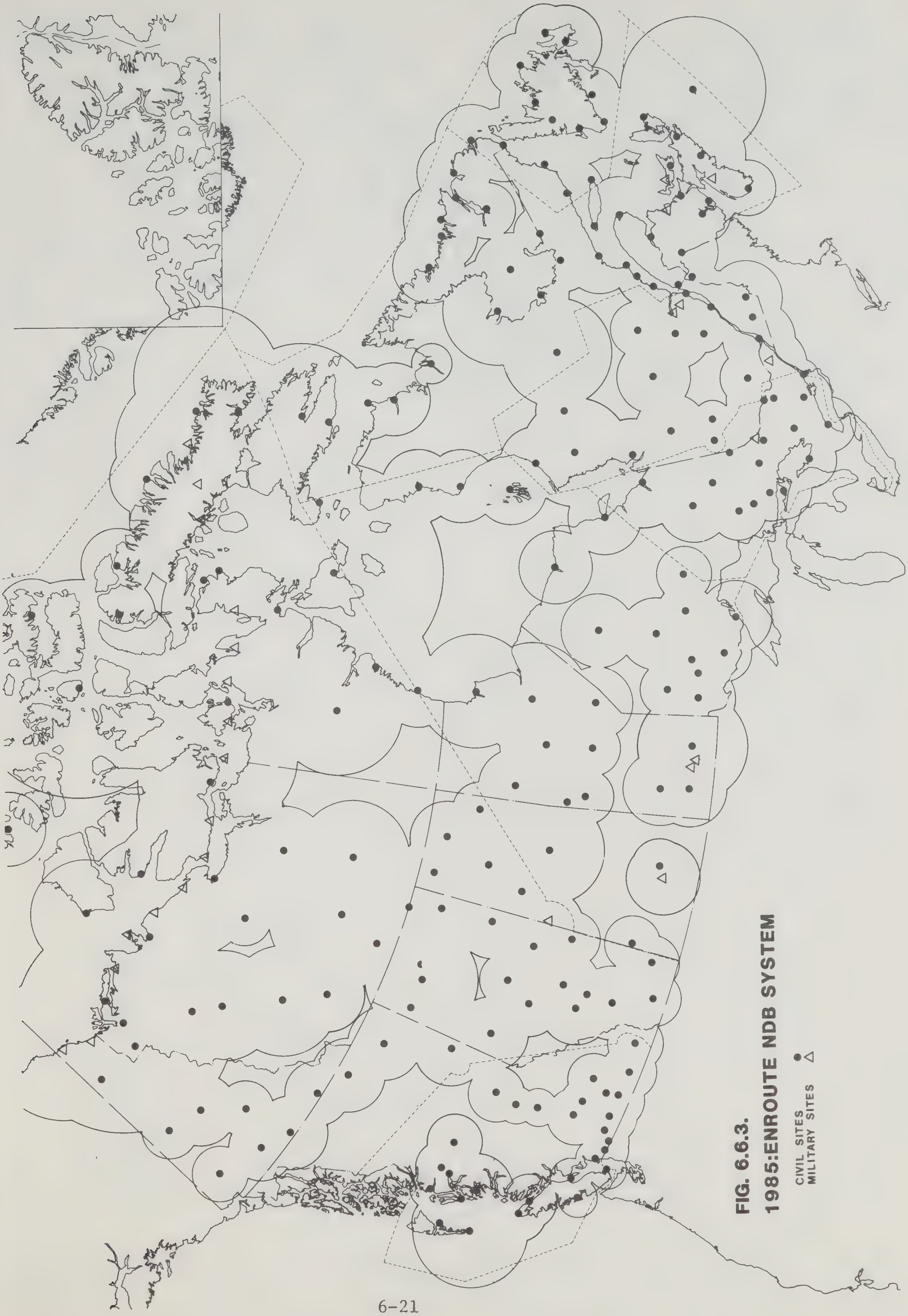


FIG. 6.6.3.
1985:ENROUTE NDB SYSTEM

CIVIL SITES ●
MILITARY SITES △

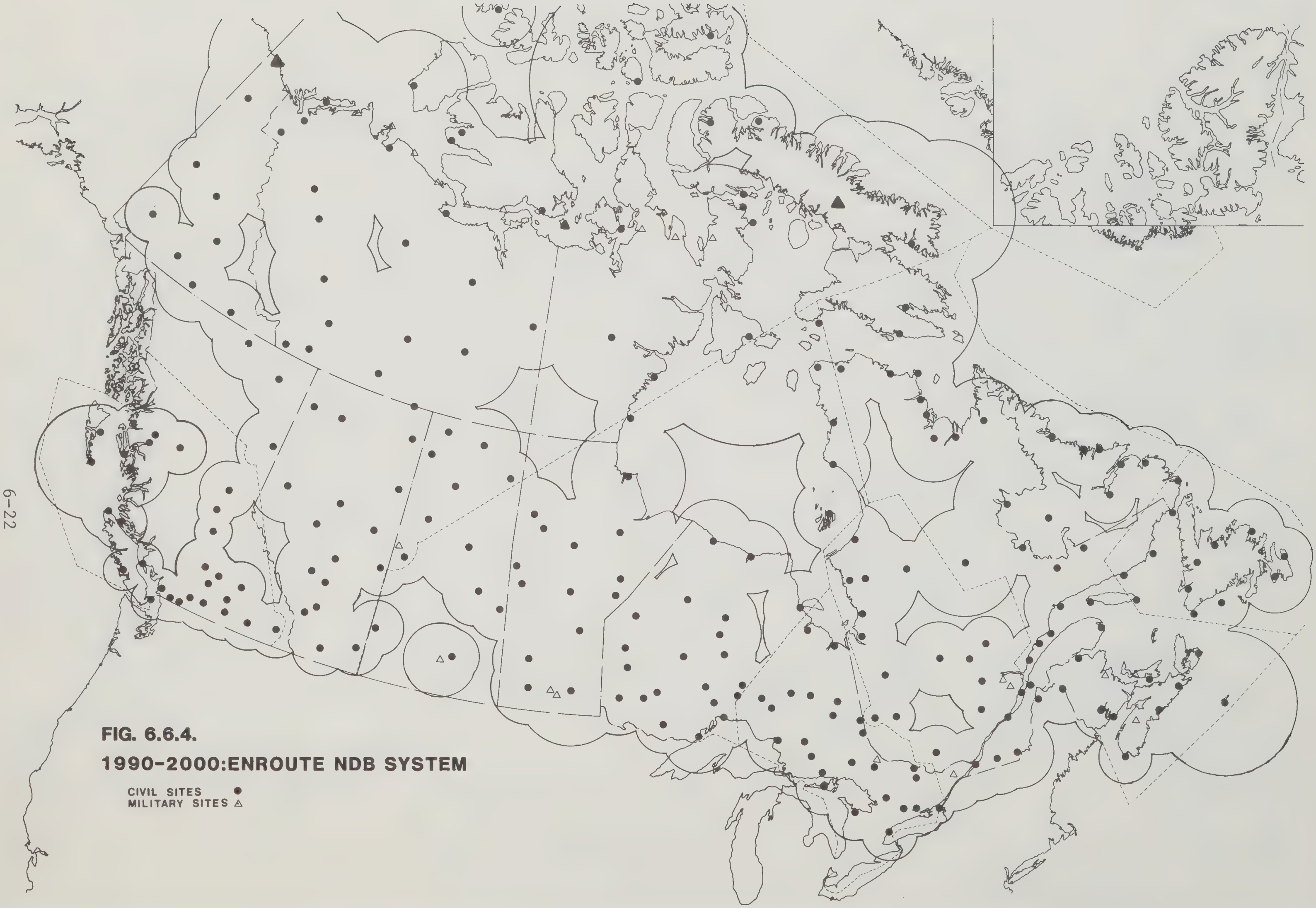


FIG. 6.6.4.

1990-2000:ENROUTE NDB SYSTEM

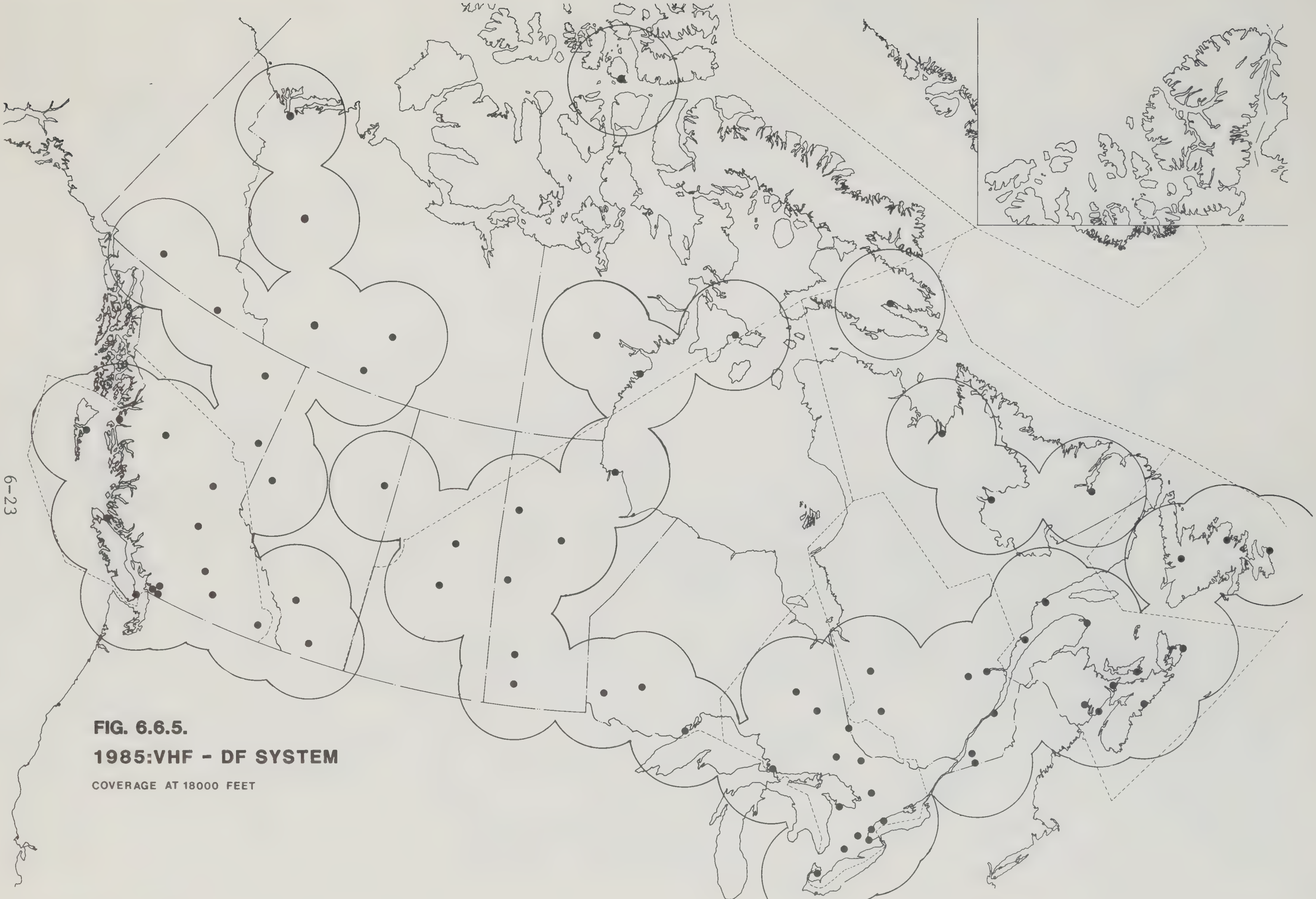


FIG. 6.6.5.
1985:VHF – DF SYSTEM
COVERAGE AT 18000 FEET

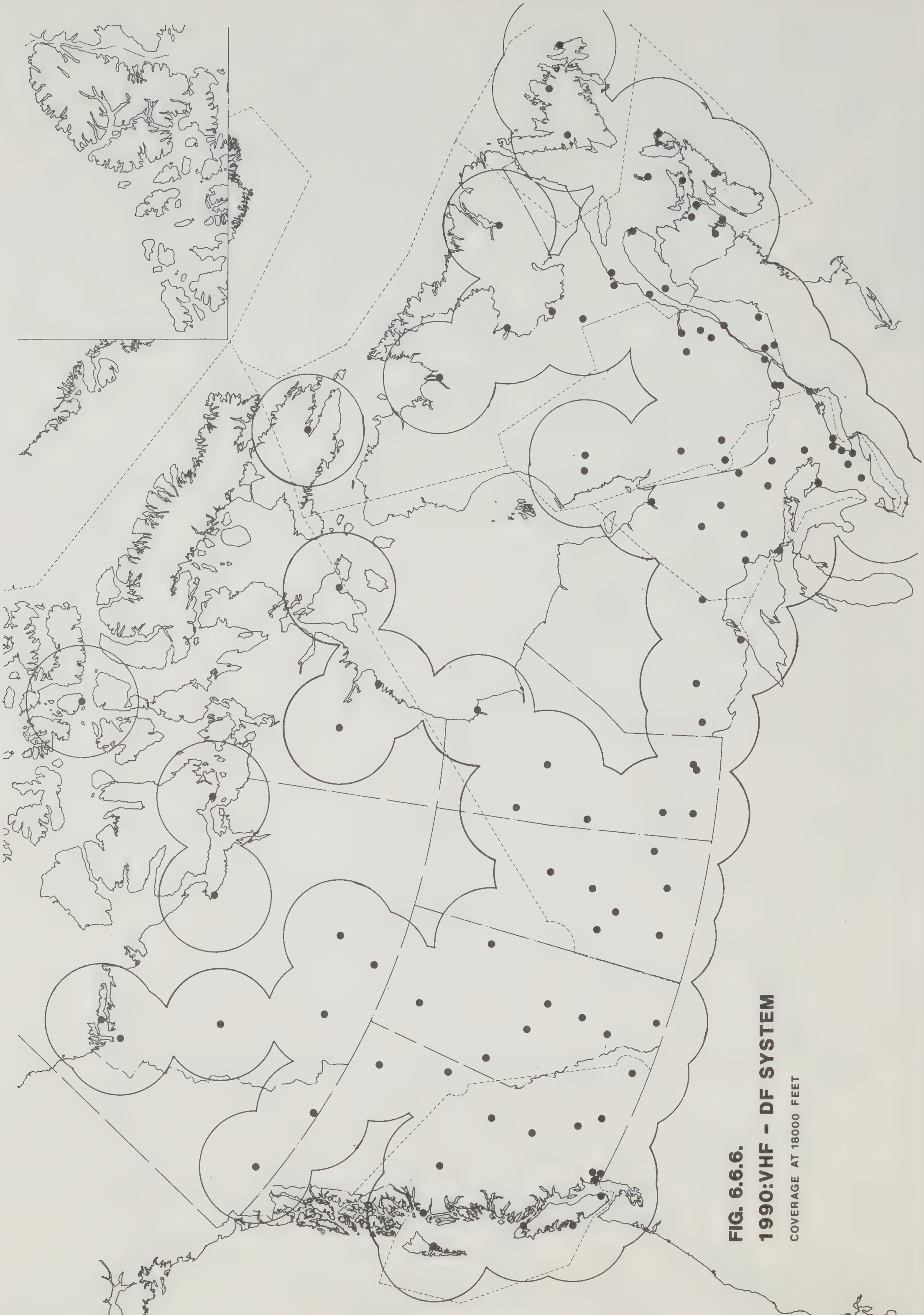


FIG. 6.6.6.

1990:VHF – DF SYSTEM

COVERAGE AT 18000 FEET

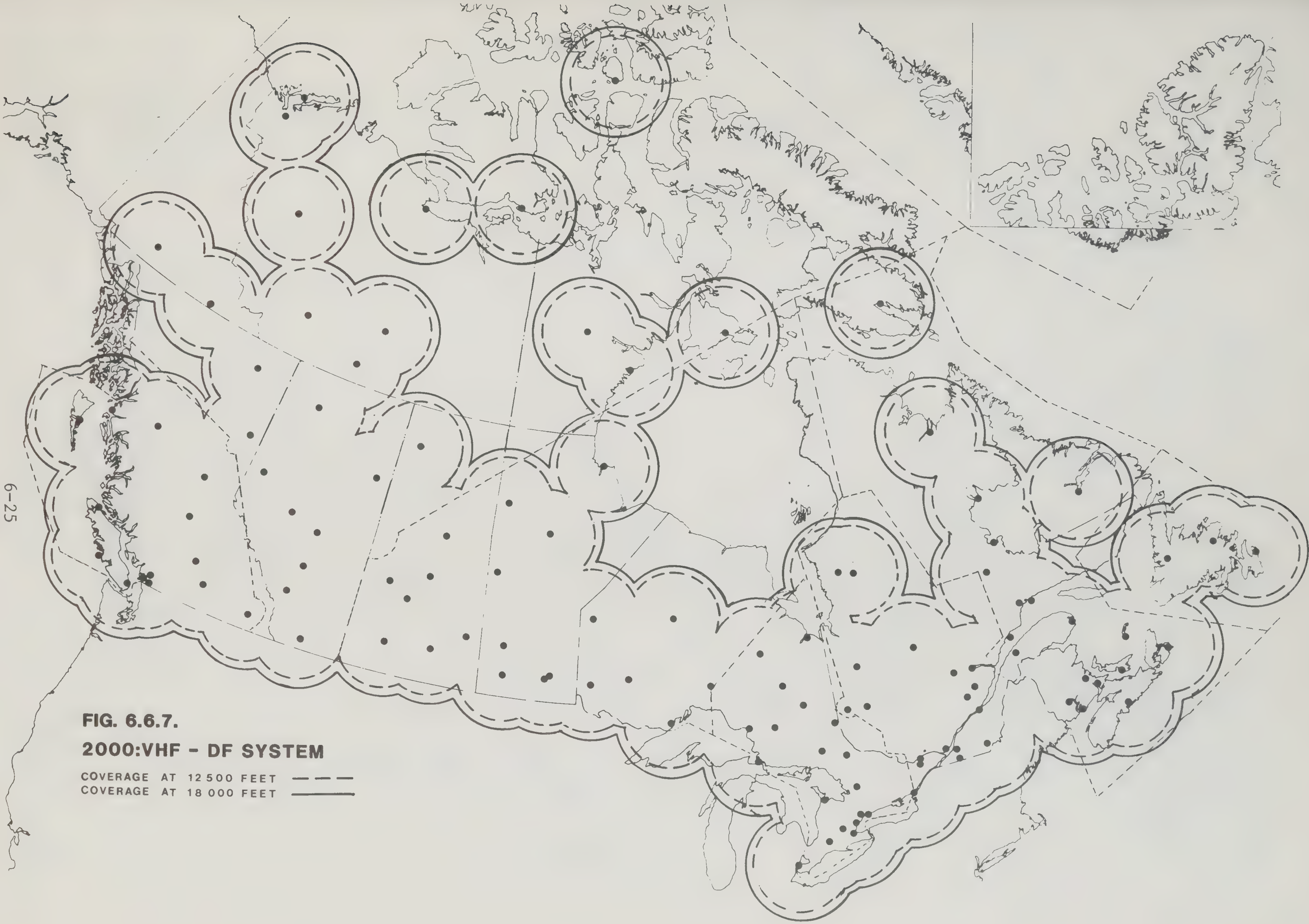


FIG. 6.6.7.
2000:VHF – DF SYSTEM

COVERAGE AT 12 500 FEET
COVERAGE AT 18 000 FEET

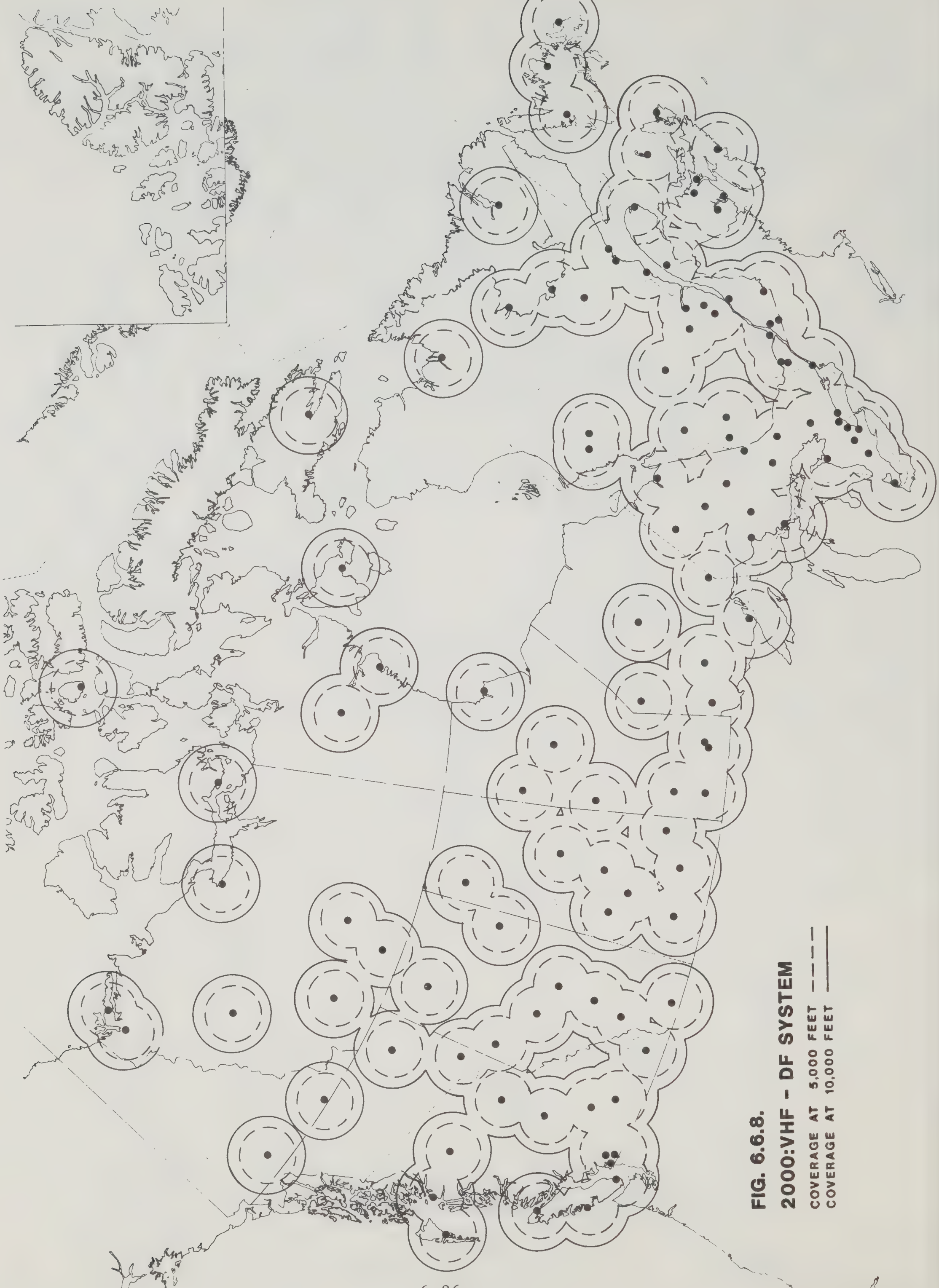


FIG. 6.6.8.
2000:VHF - DF SYSTEM

COVERAGE AT 5,000 FEET - - - - -
COVERAGE AT 10,000 FEET ———

FIG. 6.7.1.
1985:PRECISION APPROACH AIDS (ILS/RVR)

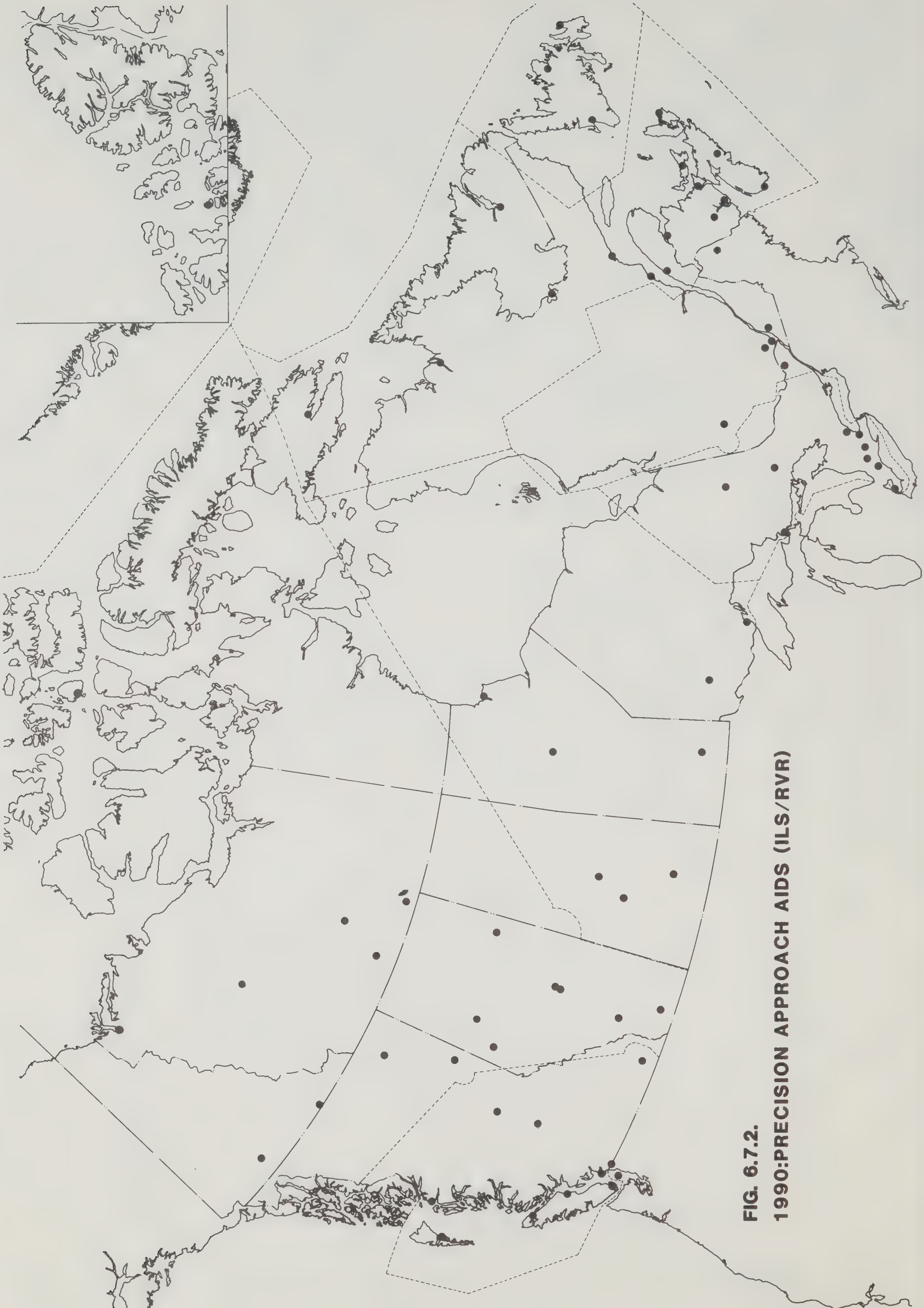


FIG. 6.7.2.
1990:PRECISION APPROACH AIDS (ILS/RVR)

FIG. 6.7.3.
2000:PRECISION APPROACH AIDS (MLS/RVR)

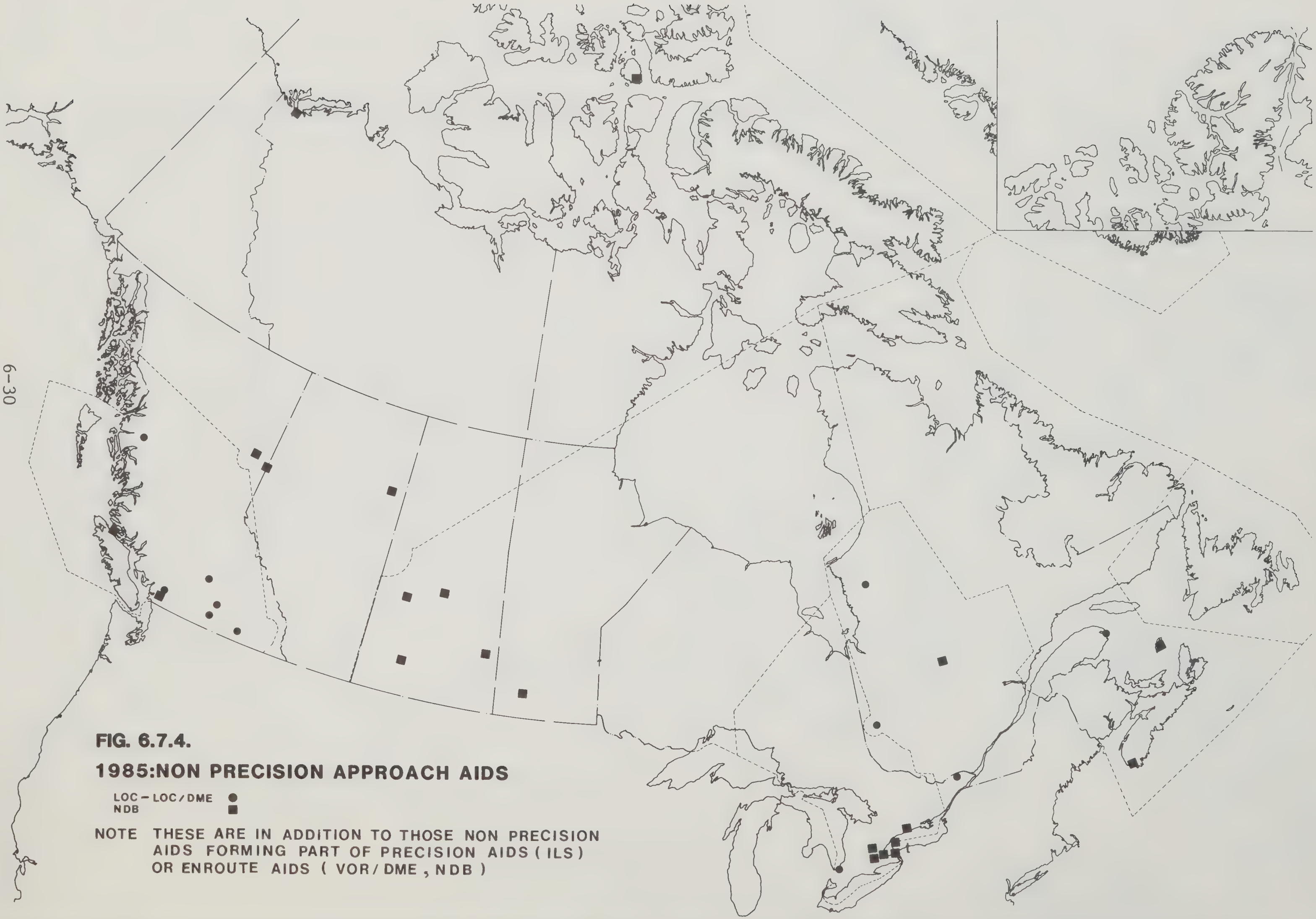


FIG. 6.7.4.

1985:NON PRECISION APPROACH AIDS

LOC – LOC/DME ●
NDB ■

NOTE THESE ARE IN ADDITION TO THOSE NON PRECISION AIDS FORMING PART OF PRECISION AIDS (ILS) OR ENROUTE AIDS (VOR/DME , NDB)

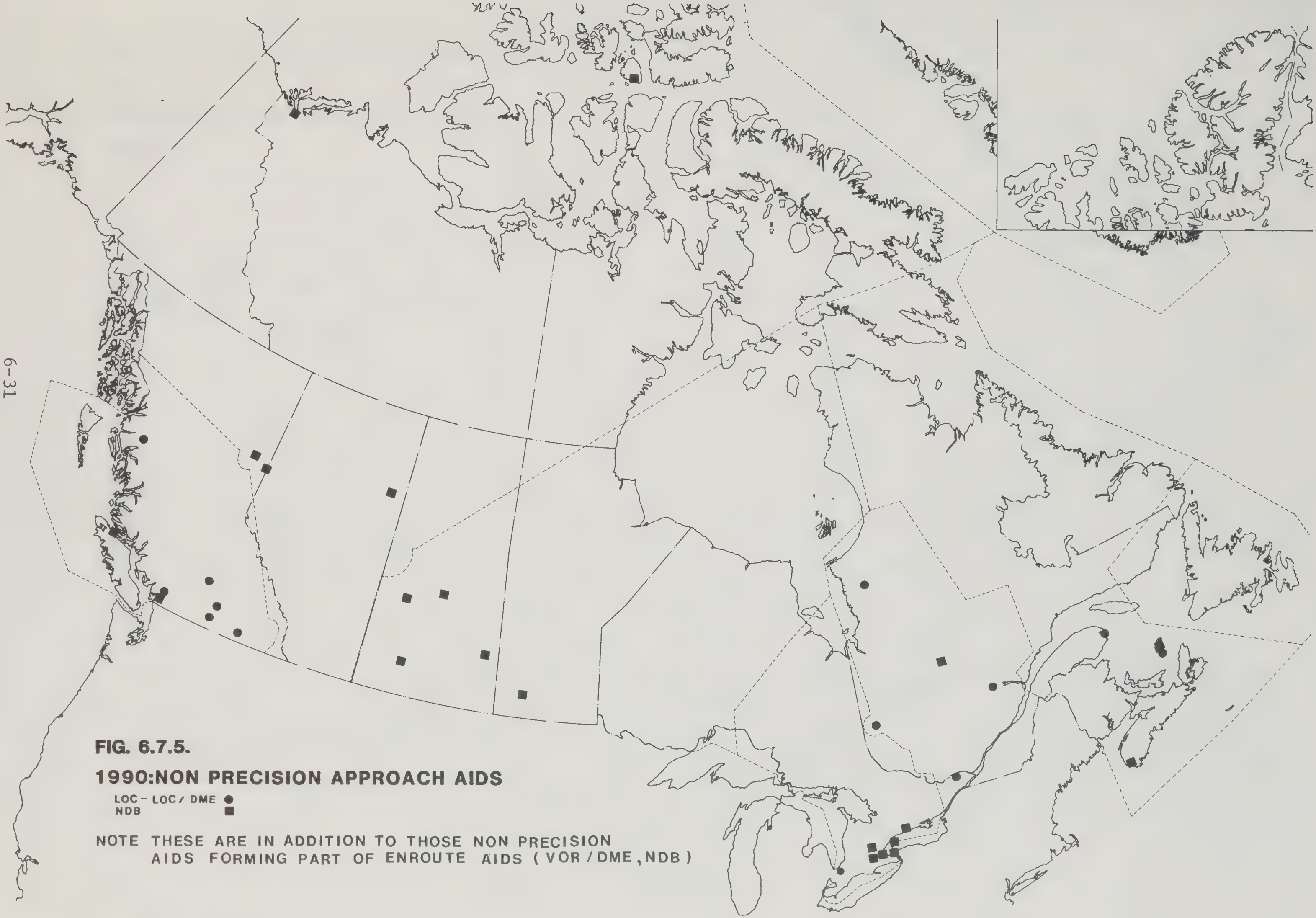


FIG. 6.7.5.

1990:NON PRECISION APPROACH AIDS

LOC - LOC / DME ●
NDB ■

NOTE THESE ARE IN ADDITION TO THOSE NON PRECISION
AIDS FORMING PART OF ENROUTE AIDS (VOR / DME, NDB)

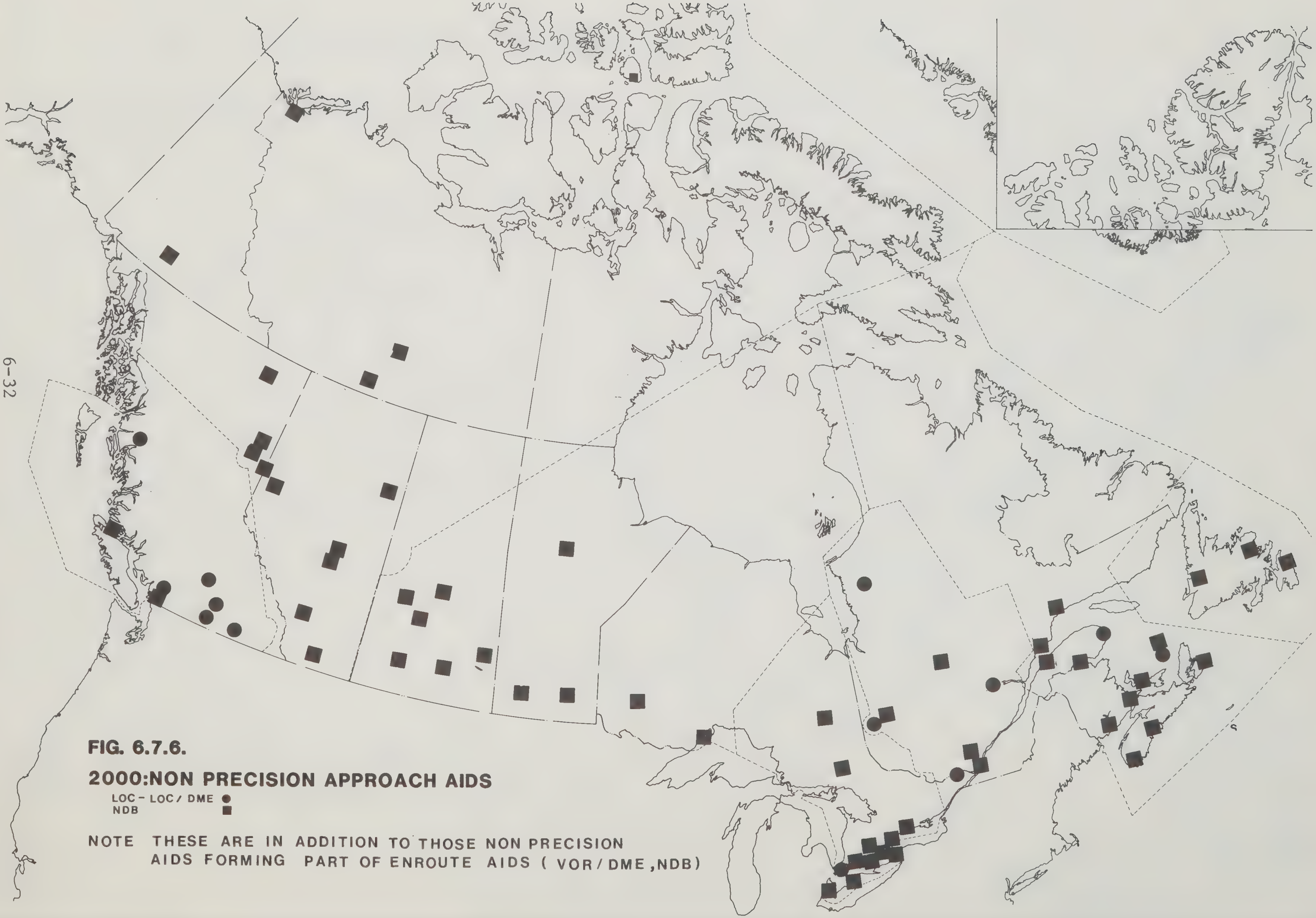


FIG. 6.7.6.

2000:NON PRECISION APPROACH AIDS

LOC - LOC/ DME ●
NDB ■

NOTE THESE ARE IN ADDITION TO THOSE NON PRECISION AIDS FORMING PART OF ENROUTE AIDS (VOR/ DME ,NDB)

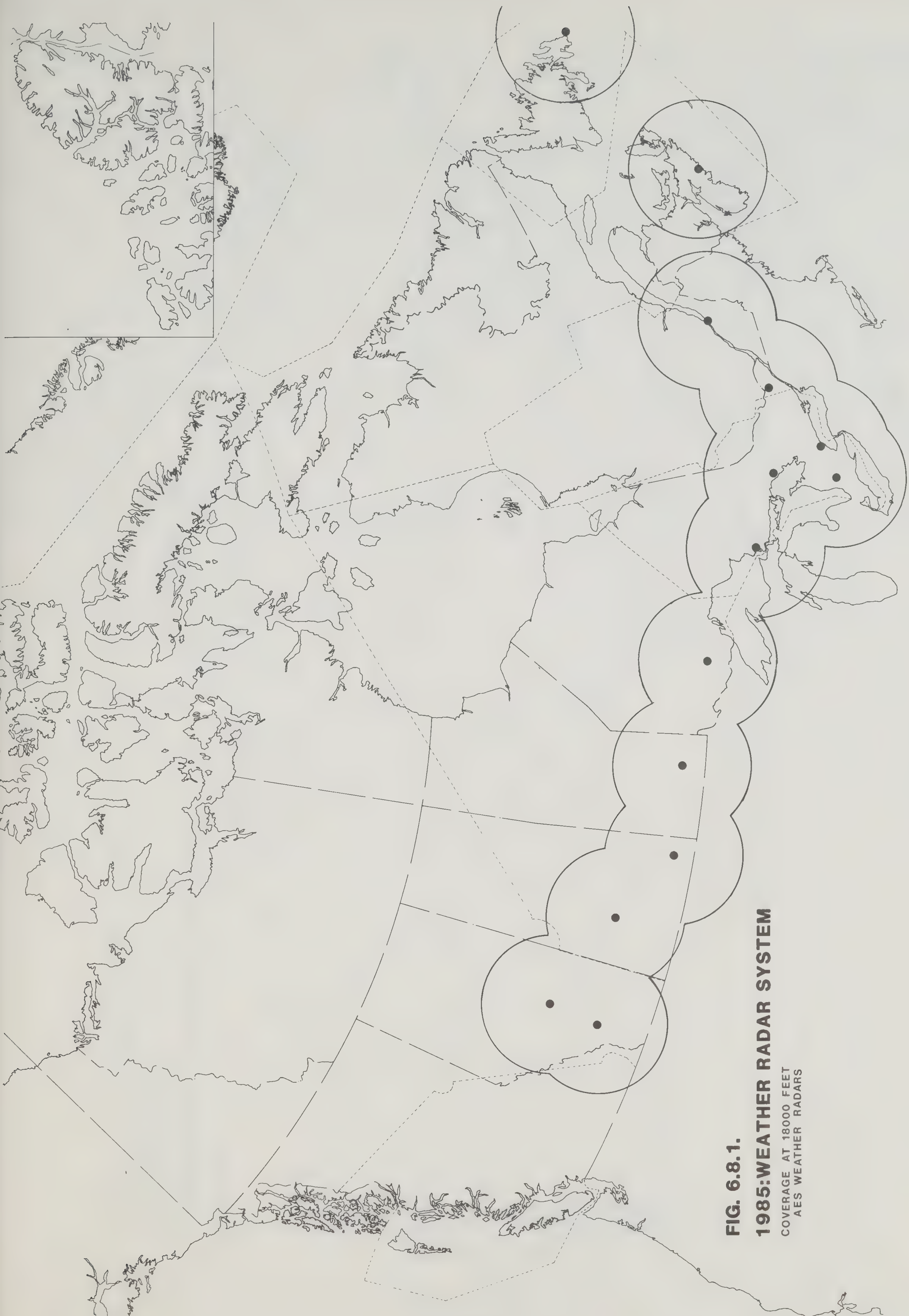


FIG. 6.8.1.
1985:WEATHER RADAR SYSTEM
COVERAGE AT 18000 FEET
AES WEATHER RADARS

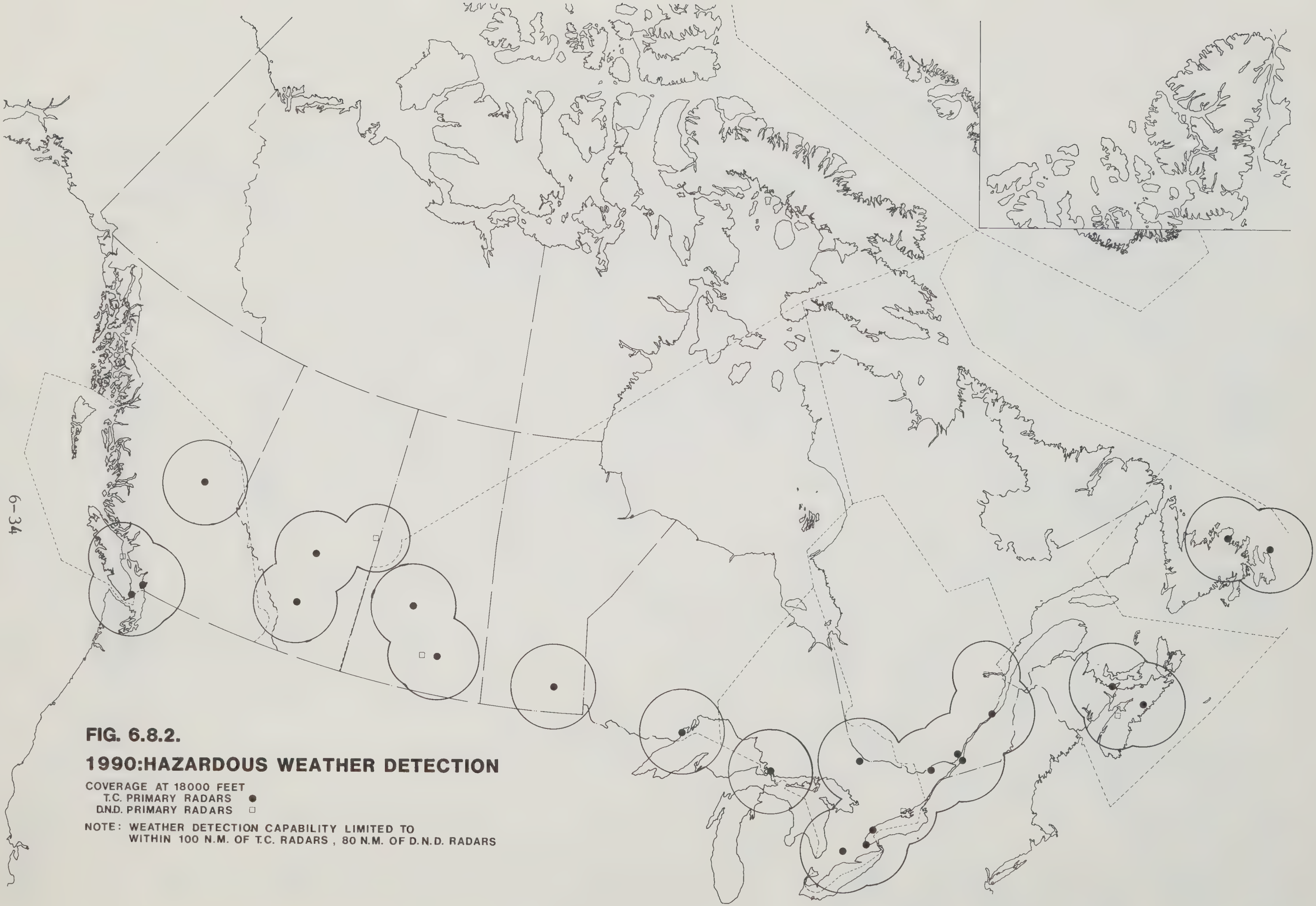


FIG. 6.8.2.

1990:HAZARDOUS WEATHER DETECTION

COVERAGE AT 18000 FEET
T.C. PRIMARY RADARS ●
D.N.D. PRIMARY RADARS □

NOTE: WEATHER DETECTION CAPABILITY LIMITED TO WITHIN 100 N.M. OF T.C. RADARS, 80 N.M. OF D.N.D. RADARS

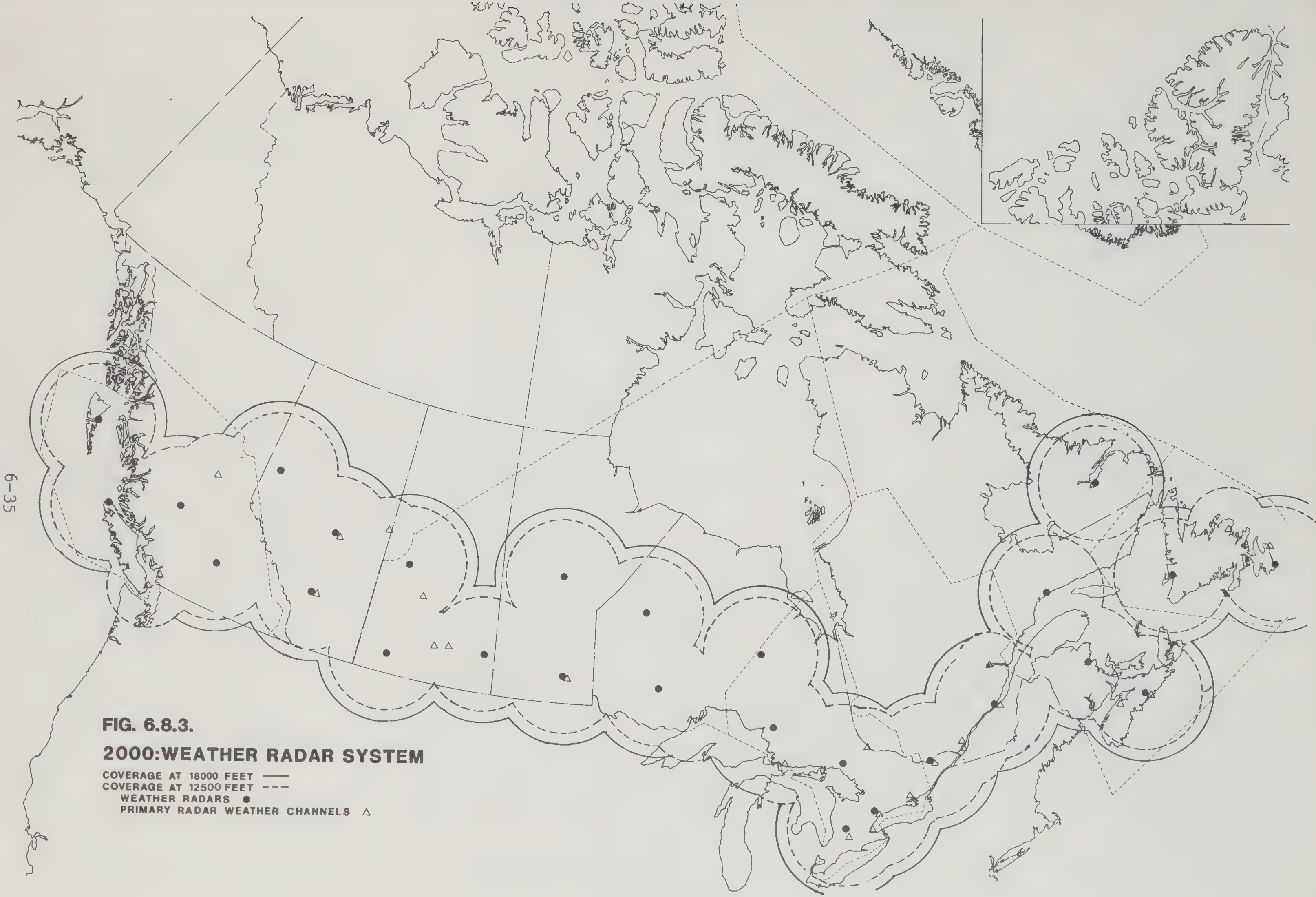


FIG. 6.8.3.

2000:WEATHER RADAR SYSTEM

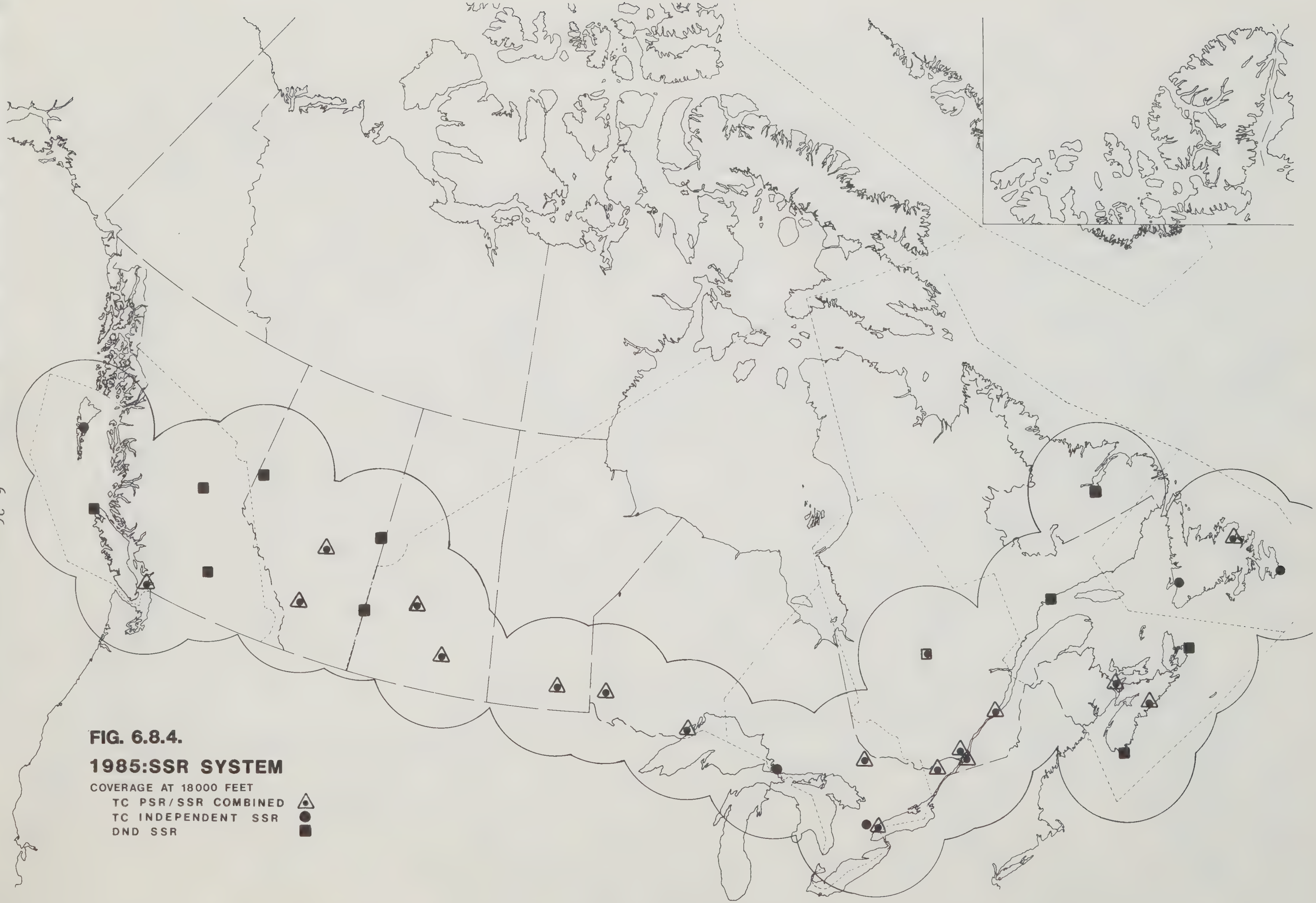


FIG. 6.8.4.

1985:SSR SYSTEM

COVERAGE AT 18000 FEET
TC PSR/SSR COMBINED
TC INDEPENDENT SSR
DND SSR

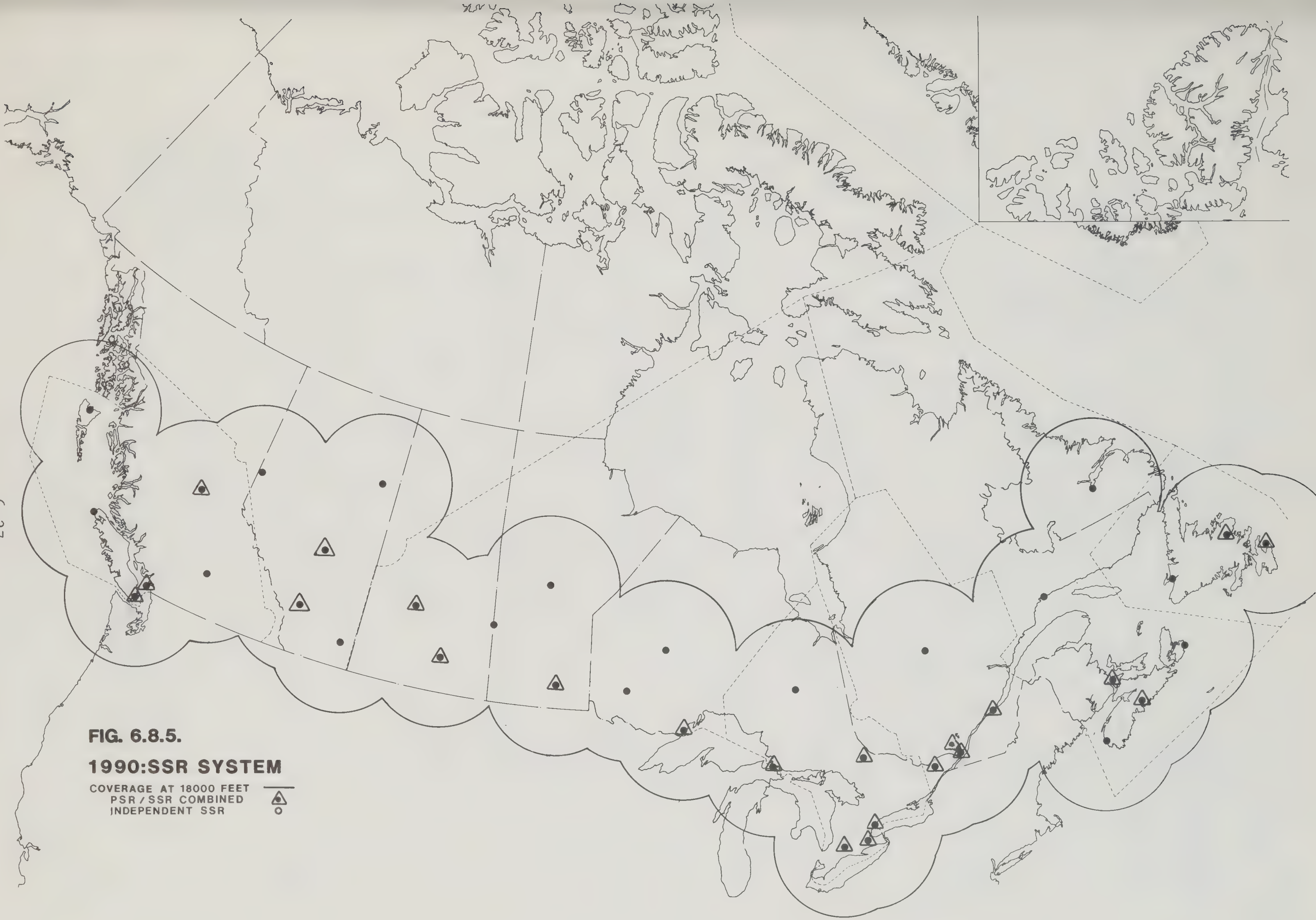


FIG. 6.8.5.

1990:SSR SYSTEM

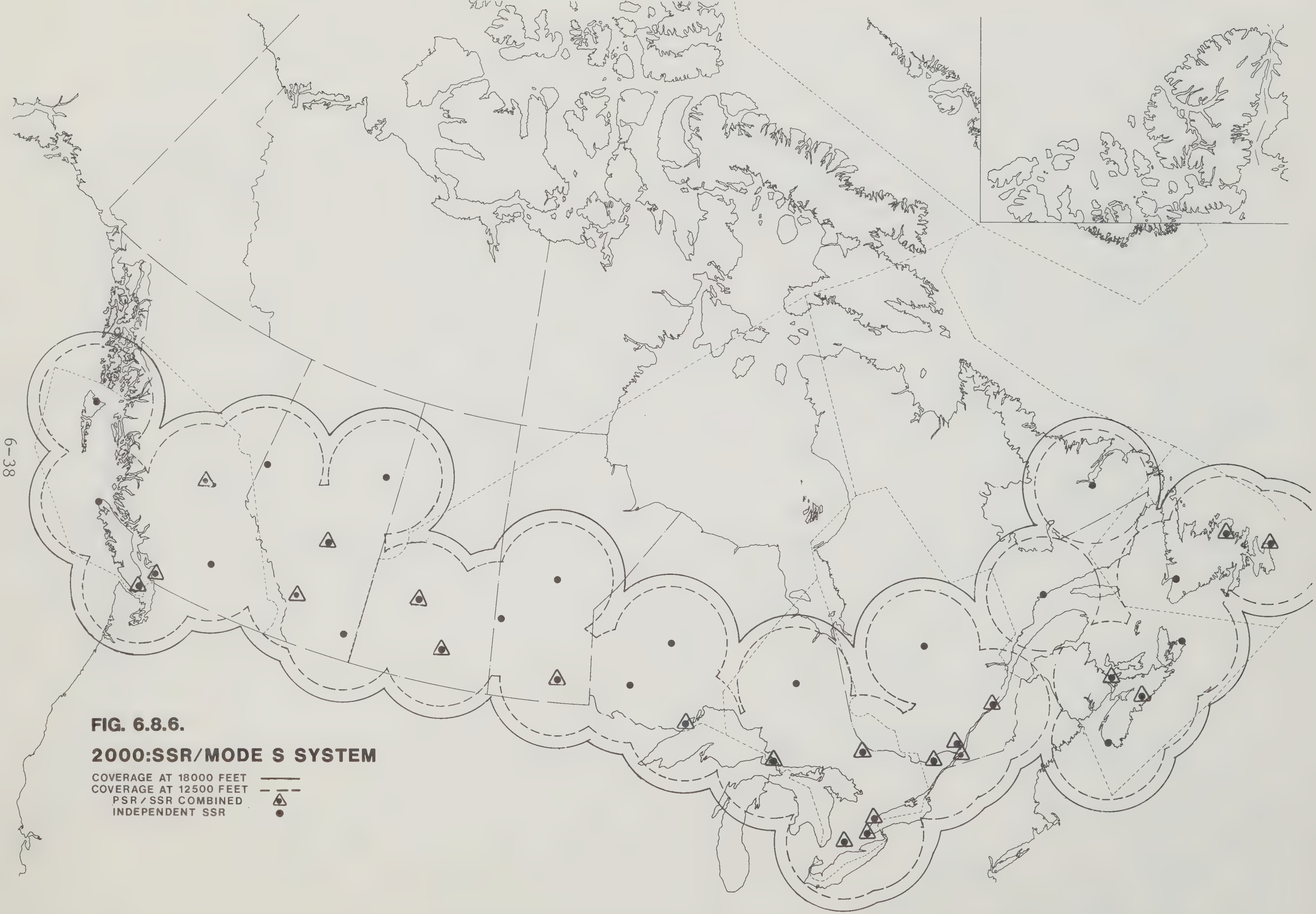


FIG. 6.8.6.

2000:SSR/MODE S SYSTEM

6.7 GROUND TO AIR PROGRAM OF PROJECTS

PROJECT	IMPLEMENTATION 1st	IMPLEMENTATION Last
COMMUNICATIONS		
1. Air Ground VHF Communications	1982	2000
2. Air Ground HF Communications	1983	1989
NAVIGATION		
3. VOR/DME/TACAN	1980	1995
4. Non-Directional Beacons	1980	1995
5. VHF/DF	1984	1995
LANDING SYSTEMS		
6. Instrument Landing Systems (ILS)	1980	1987
7. Microwave Landing System (MLS) including Precision DME (DME-P)	1989	2000
8. RVR Systems	1982	2000
SURVEILLANCE		
9. Weather Radar	1982	2000
10. Radar Modernization Project (RAMP)	1987	1992
11. Airport Surface Detection Equipment	1986	1989
12. SSR Mode S Data Link	1994	2000
GENERAL		
13. Consolidation of Communications, Navigation and Surveillance Facilities.	1985	2000

PROJECT: 1. AIR GROUND VHF COMMUNICATIONS

PURPOSE: To replace obsolete VHF communications equipment with highly reliable state-of-the art models capable of operating in a 25 kHz environment. Antennas are being replaced with designs that will provide better coverage patterns and higher isolation. Also, transmitters, receivers, multi-couplers and antennas are being provided to meet the expansion of air traffic services and for the extension of communication services to remote areas.

Increases in the demand for communication services in air traffic services have generated a requirement for additional channels. This can only be accomplished in the frequency spectrum by decreasing the channel spacing to 25 kHz. This channel spacing cannot be done economically with the older equipment.

The higher reliability associated with modern equipment makes it possible to reduce the requirement for periodic maintenance resulting in a savings of 40 hours per year for each transmitter and receiver pair.

A reduction in power consumption is resulting from the conversion to more efficient equipment. It is estimated that 2.0 megawatt-hours per year is being saved by each transmitter/receiver pair.

APPROACH: The project has been planned on a multi-year procurement basis in three phases

Phase I: Replace remote communications equipment.
Phase II: Replace communications equipment at TWR's, TCUs and ACCs completed.
Phase III: Replace communications equipment at FSS's.

QUANTITIES:

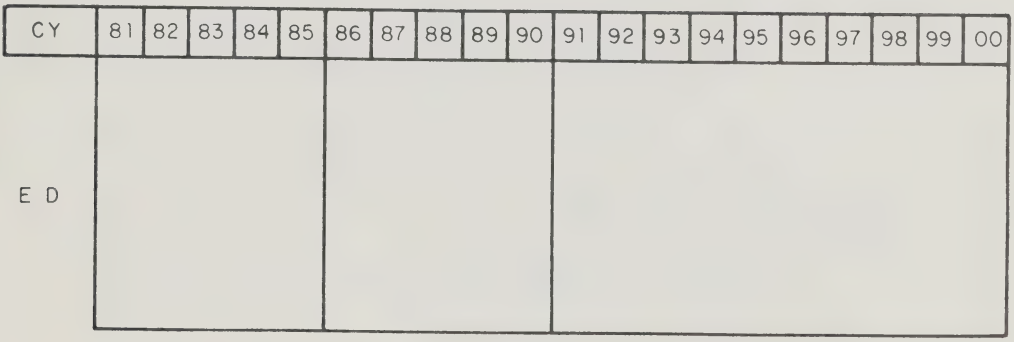
	Replacement	New
Completed	450 Transmitters	50 Transmitters
	325 Receivers	50 Receivers
	300 Dual Antennas	50 Antennas
		50 Multicouplers
Completed	580 Transmitters	340 Transmitters
	460 Receivers	340 Receivers
	200 Dual Antennas	150 Antennas
		140 Multicouplers
By 1990	310 Transmitters	140 Transmitters
	560 Receivers	140 Receivers
	200 Dual Antennas	100 Dual Antennas
		50 Multicouplers

RELATED PROJECTS/ACTIVITIES:

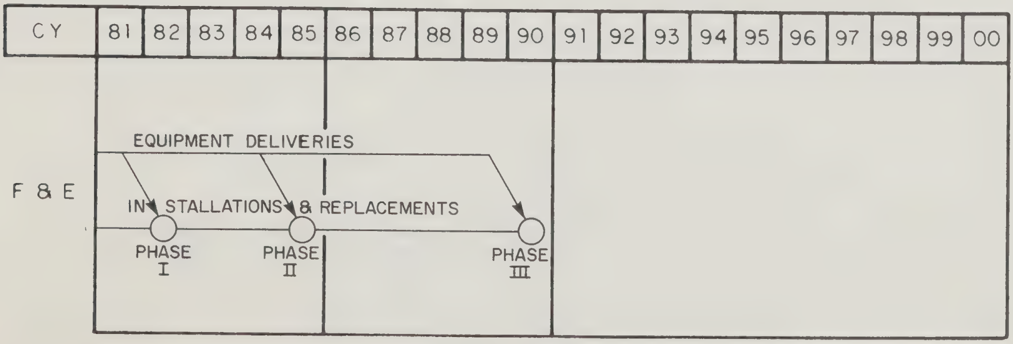
- Consolidation of Communication, Navigation and Surveillance facilities.
- Consolidation of Air Navigation Systems Facilities (Development)
- Speech Processing and Transmission Systems Development
- Advanced Air/Ground Communication and Data Link Studies

AIR-GROUND VHF COMMUNICATIONS

SCHEDULE



SCHEDULE



PROJECT: 2. AIR GROUND HF COMMUNICATIONS

PURPOSE: To replace obsolete tube-type transmitters and receivers with more reliable, efficient solid-state equipment. This equipment is used principally on the 5680 kHz service available at northern Flight Service Stations to provide communications with aircraft operating beyond the VHF range in the low density traffic area. Some equipment is also required to provide ICAO service for International air ground communications and to provide for grd - grd links.

Existing equipment exhibits poor availability, high energy utilization and high maintenance costs. It also fails to meet international frequency stability requirements. The new units will decrease maintenance and energy costs by at least 50%.

APPROACH: The project has been planned on a multi-year procurement basis. The first phase will replace the international air-ground equipment by 1985 while the second will replace 5680 kHz equipment by 1989.

QUANTITIES: The planned replacement schedule is as follows.

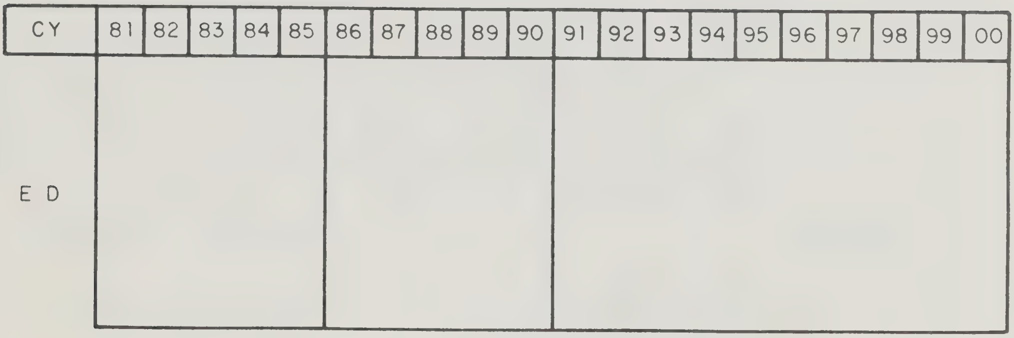
	1982/83	18 Transmitters	Completed
By	1986/87	32 Transmitters 41 Receivers	
By	1987/88	30 Transmitters 40 Receivers	
By	1988/89	30 Transmitters 40 Receivers	

RELATED PROJECTS/ACTIVITIES:

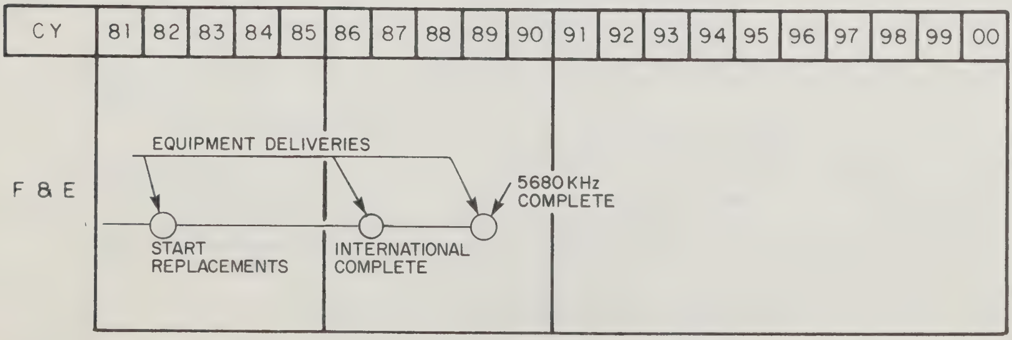
- Advanced Air/Ground Communications and Data Link Studies
- Automatic Dependent Surveillance Investigations.

AIR-GROUND HF COMMUNICATIONS

SCHEDULE



SCHEDULE



PROJECT: 3. VOR-DME-TACAN

PURPOSE: To provide for new and replacement VOR, DME and TACAN systems. VOR and DME are used for enroute airway navigation, to provide navigation data to airborne area navigation systems and, in some cases, as approach aids. TACAN is a system used as a VOR-DME equivalent by the military and to provide DME information for civil aircraft from colocated VOR/TACANS.

APPROACH: Replacements - There are 32 VOR systems remaining to be replaced with solid state equipment during the period 1985-1990. A program will be established with DND to replace 32 collocated TACAN's between 1987 and 1990. No DME's will be replaced since all existing systems are currently solid state.

New requirements - Additional VOR-DME's will continue to be installed both for airway and area navigation in the high density traffic area and will eventually enable aircraft to operate on fuel efficient random routes. Expansion of the VOR-DME system may continue at a rate of 2 to 3 systems per year until 1995 depending on results of a benefit/cost analyses.

Relocations - Due to performance decline, route structure changes or real estate considerations it becomes necessary to convert standard VOR to Doppler VOR or to relocate facilities to airport locations from time to time.

Upgrades - The new VOR, DME and TACAN equipment which will be procured after 1985 will incorporate full remote maintenance monitoring capability. Retrofit programs will be established to incorporate remote maintenance monitoring techniques into equipment procured prior to 1985. The incorporation of continuous weather broadcasts on VOR will be carried out in conjunction with investigation of the desirability of utilizing voice identification in accordance with user-demand.

QUANTITIES:

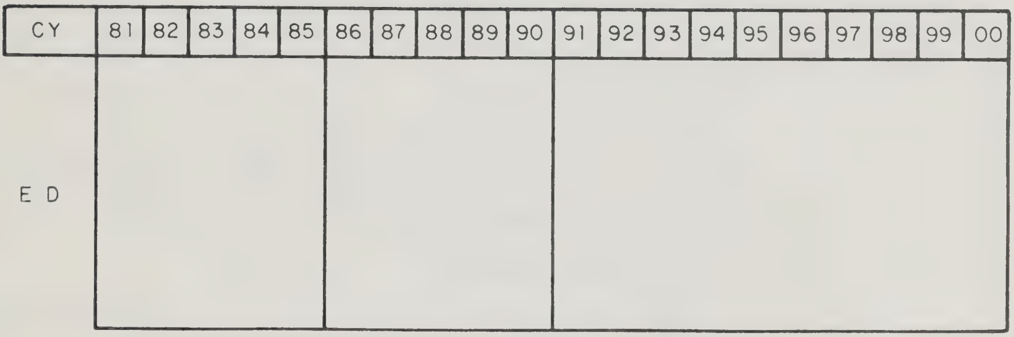
		1986-1990	1991-2000
Replace DME		--	110
Replace SVOR/DVOR		30	30
Replace TACAN		32	--
Retrofit VOR/DME RMM		50	70
Establish new SVOR/DVOR		4	As required
Replace & Establish VOT		20	
Disaster Replace	VOR/DME	1	1
	VOT	1	1
	VORTAC	1	1

RELATED PROJECTS/ACTIVITIES:

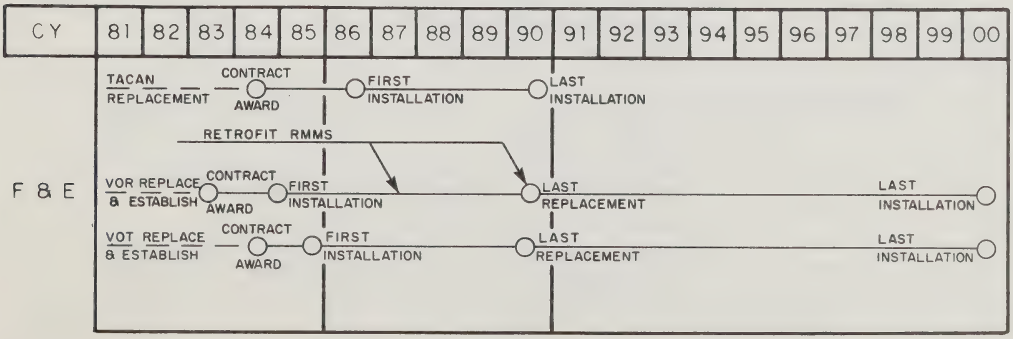
- Consolidation of communications, navigation and surveillance
- Remote Maintenance and Monitoring Development
- Navigation Satellite System Support Development
- Control and Performance Monitoring System
- Loran 'C' Coverage Studies
- VLF/Navigation Transmitter Evaluations

VOR - DME - TACAN

SCHEDULE



SCHEDULE



PROJECT: 4. NON-DIRECTIONAL BEACONS

PURPOSE: To provide for the extension of the route structure to locations not presently served and to provide additional airports with non-precision approach guidance, expansion of the NDB system is required. The non-directional beacon (NDB) is a low/medium frequency facility that transmits omnidirectional signals whereby the aircraft pilot can determine his bearing and "home" in on the station. NDB's are used as navigation fixes defining air routes, as non-precision approach systems and as compass locators for precision landing systems. About half of the existing NDB installations require replacement with solid state equipment.

APPROACH: Establish, replace, retrofit and colocate with other facilities to provide solid state equipment with remote maintenance monitoring capability.

QUANTITIES:

	1982-85	1985-90	1990-2000
Establish NDB's - Enroute	20	15	-
NDB's - Approach	15	15	30
Replace NDB's - Enroute	40	20	-
- Approach	40	20	-
Retrofit NDB with RMM - All			

	1982	1985	1990	2000
NDB's (Enroute & Approach)	393	428	458	488

The following assumptions have been made:

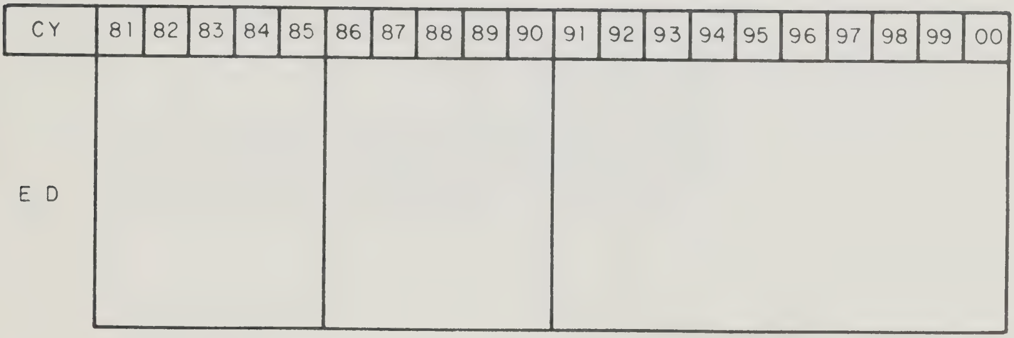
- Zero growth of enroute NDB's will occur between 1990 and 2000.
- NDB's associated with ILS will be retained for non-precision approach when MLS is installed.
- Quantities to be confirmed

RELATED PROJECTS/ACTIVITIES:

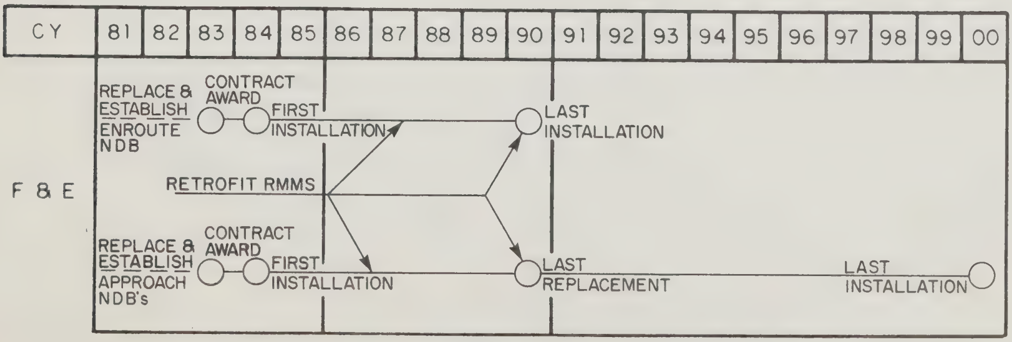
- VOR-DME - TACAN
- Remote Maintenance and Monitoring Development
- VLF/Navigation Transmitter Evaluations
- Loran C Coverage Studies
- Navigation Satellite Systems Support Development
- Consolidation of Air Navigation System Facilities
- Alternative Power Sources

NON-DIRECTIONAL BEACONS

SCHEDULE



SCHEDULE



PROJECT: 5. VHF-DF

PURPOSE: To expand the VHF-DF coverage in order to provide assistance to pilots experiencing navigational difficulty. Some relocation will be carried out to consolidate VHF-DF sites with other facilities. Limited remote maintenance monitoring will be incorporated.

APPROACH: The existing coverage provided by terminal VHF-DF's will be expanded by additional systems and by suitably located enroute systems. Output bearing data from DF's will be correlated in order to establish aircraft fixes where overlapping coverage by two or more DF's is available. Remote maintenance monitoring will be retrofitted into all existing and future installations.

QUANTITIES:

	1981-85	1985-1990	1990-2000
Establish DF	3	30	7
Colocate DF	-	10	30
Retrofit with RMM			121

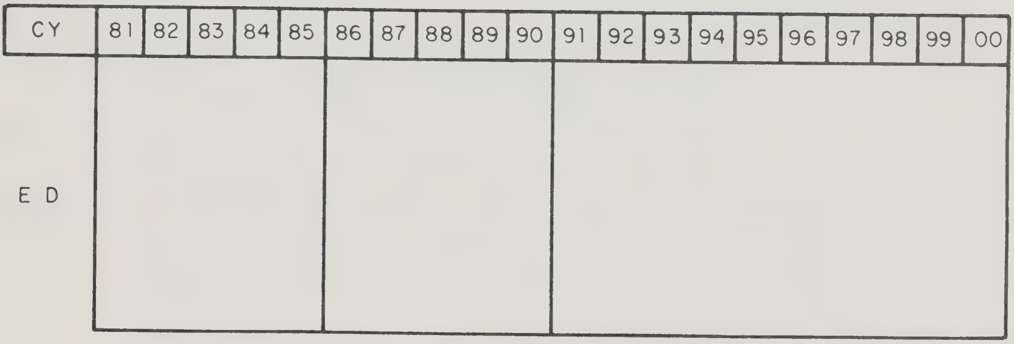
	1982	1985	1990	2000
VHF/DF	81	84	114	121

RELATED PROJECTS/ACTIVIVITIES:

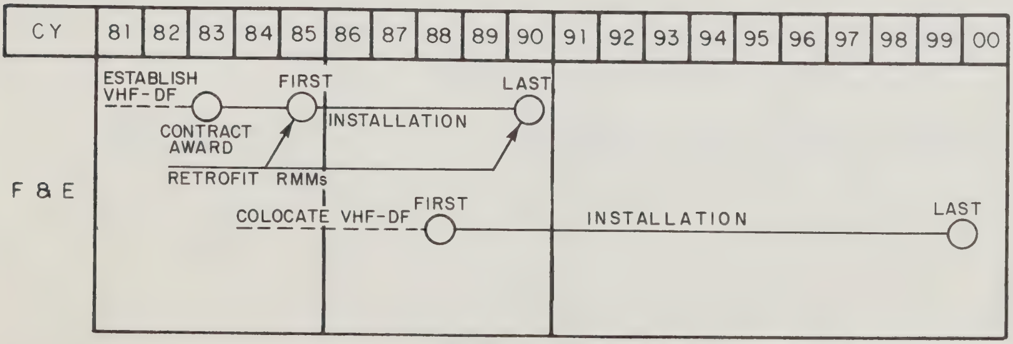
- Flight Information Services Automation
- Canadian Aeronautical Digital Network
- Remote Maintenance and Monitoring Development
- Consolidation of Air Navigation System Facilities

VHF - DF

SCHEDULE



SCHEDULE



PROJECT: 6. INSTRUMENT LANDING SYSTEMS - ILS

PURPOSE: To complete the ILS replacement program and to establish new ILS installations. This project will also involve the incorporation of remote maintenance monitoring into existing ILS equipment.

APPROACH: Contracts will be issued for equipment to replace existing tube type equipment and to satisfy the establishment of new ILS at selected locations. The remote maintenance monitoring requirements for ILS will be established and retrofit of these systems will be carried out. Due to the 1998 protection date for ILS and the planned withdrawal of these systems by 2000, the last new ILS is expected to be established in 1990. Beyond that date the installation of MLS will be preferred.

QUANTITIES:

	1982-85	1985-90	1990-2000
Replace ILS	15	20	-
Establish ILS	5	10	-
Retrofit ILS with RMMS	-	102	-

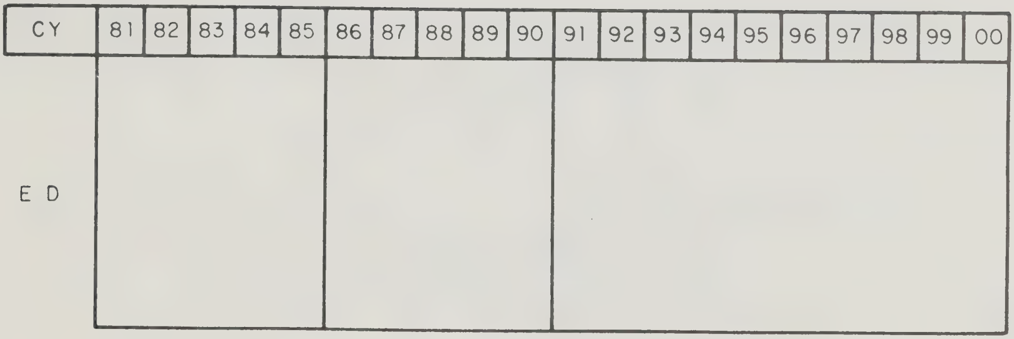
	1982	1985	1990	2000
No. of ILS	87	92	103	-

RELATED PROJECTS/ACTIVITES:

- Microwave Landing System Project
- Remote Maintenance and Monitoring Development
- Microwave Landing System Support Development

ILS

SCHEDULE



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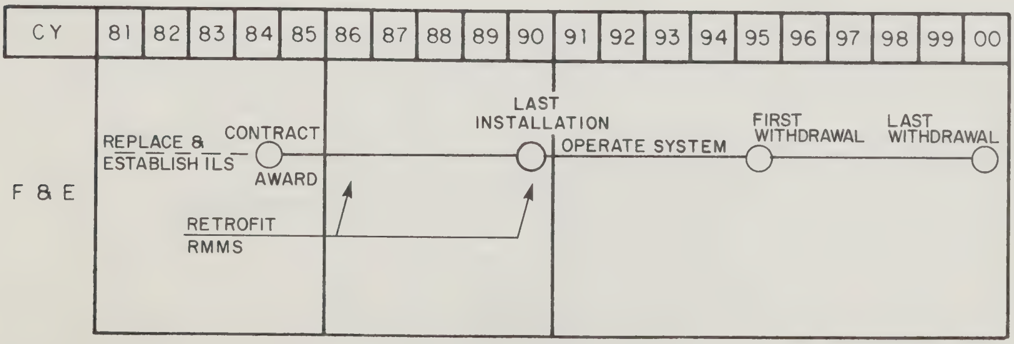


PROJECT: 7. MICROWAVE LANDING SYSTEM (MLS) INCLUDING PRECISION DISTANCE MEASURING EQUIPMENT (DME-P).

PURPOSE: To implement a transition from the current instrument landing system to the new international standard MLS incorporating a new more precise distance measuring equipment. The international protection date for the current system (ILS) is Jan 1, 1998. Most MLS installations will have to be carried out over the period 1989 - 1998 so that Canada will be in a position to withdraw ILS from service on Jan 1, 1998. This project provides for normal expected growth in precision landing systems to the year 2000 and may include implementation of Category III where the qualification criteria have been satisfied.

APPROACH: MLS will be installed in parallel with the current system between 1989 and 1998. After 1989 airports requiring new precision approach equipment will be provided with MLS rather than ILS.

The initial testing of MLS will be carried out under an existing test program until 1986 at which time a specification will be developed and MLS procurement action will be undertaken. Development of DME-P will occur and be integrated with the MLS system.

QUANTITIES: MLS will be acquired in accordance with the following delivery schedule:

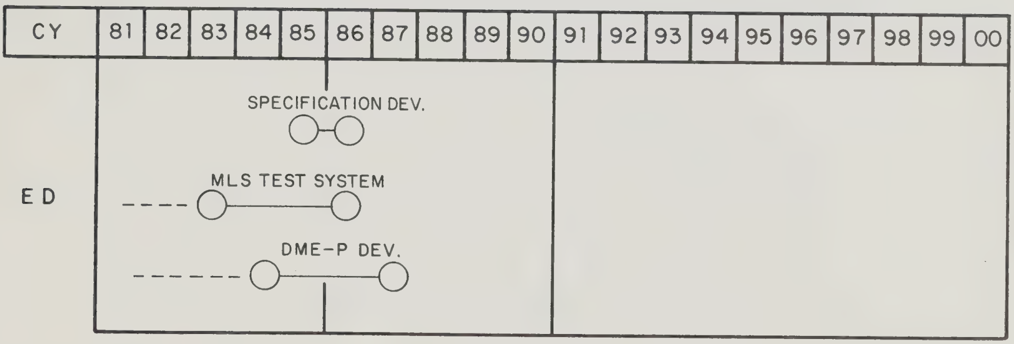
1987 - 1991 - 41 Phase I
1991 - 2000 - 113 Phase II

RELATED PROJECTS/ACTIVITIES:

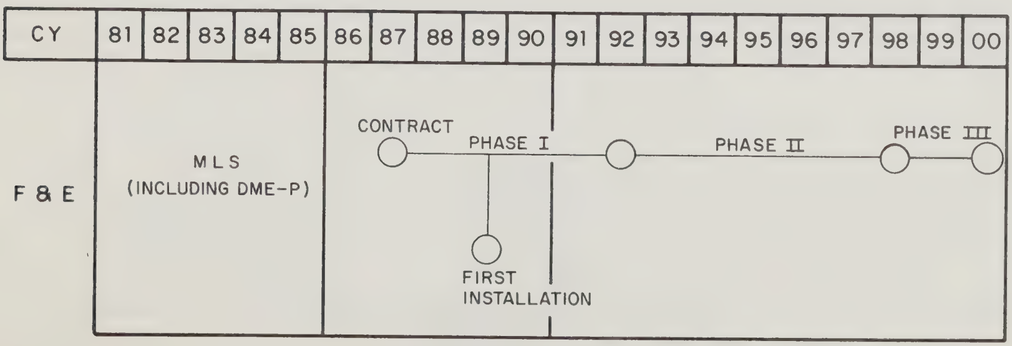
- Instrument Landing System
- Microwave Landing System Support Development
- Flight Inspection System Development

MLS (INCLUDING DME-P)

SCHEDULE



SCHEDULE



PROJECT: 8. RVR SYSTEMS

PURPOSE: To convert existing RVR systems to solid state technology and to provide RVR for new precision approach systems.

APPROACH: Initially, new solid state transmissometers will replace existing units. New RVR computer design with remote maintenance monitoring features will be incorporated in existing and new installations beginning in 1984. Contracts will be issued to industry for both transmissometer and RVR computer production. Engineering development into new improved sources of light for the transmissometer will be carried out toward the latter part of the period.

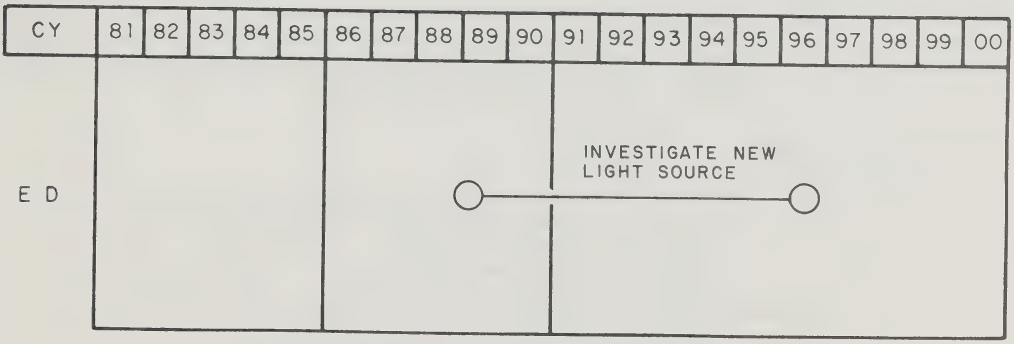
QUANTITIES: To be determined.

RELATED PROJECTS/ACTIVITIES:

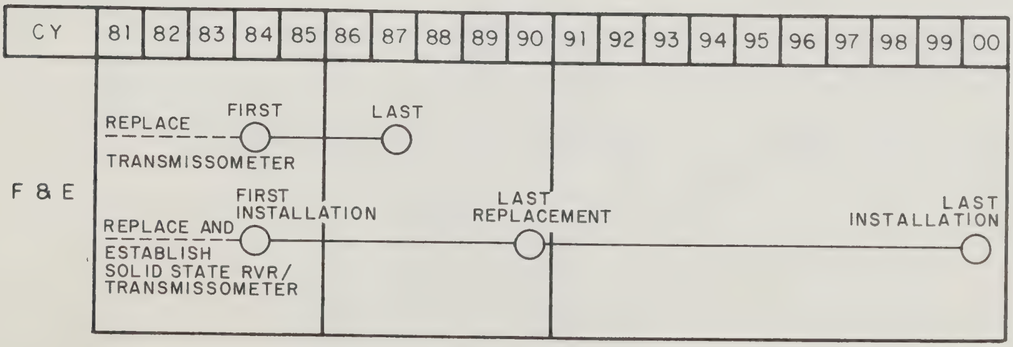
- Weather Detection, Processing and Dissemination Systems

RVR SYSTEMS

SCHEDULE



SCHEDULE



PROJECT: 9. WEATHER RADAR

PURPOSE: To establish an aviation weather radar network that will provide timely and accurate aviation weather data for dissemination to ATS and aviation users.

Real time information on hazardous weather relative to flight is presently neither adequate nor readily available. Limited and unreliable information leads to unexpected or uncoordinated traffic diversions, fuel inefficient routings, and can result in unsafe flight conditions. In addition to improvements to be gained, future automated ATC functions such as flow management, conflict prediction and advanced integration of the ATC system will require reliable and accurate real time weather data.

APPROACH: Coverage will be provided by Atmospheric Environment Services and Transport Canada weather radars, the weather radar channels from RAMP primary radars and possibly DND ATC radars, and adjoining U.S. weather radar systems.

By the year 2000 the combined network of weather radar sensors will provide total coverage of hazardous weather information at 18000 ft and above (to 12,500 in critical areas) in the high traffic density airspace.

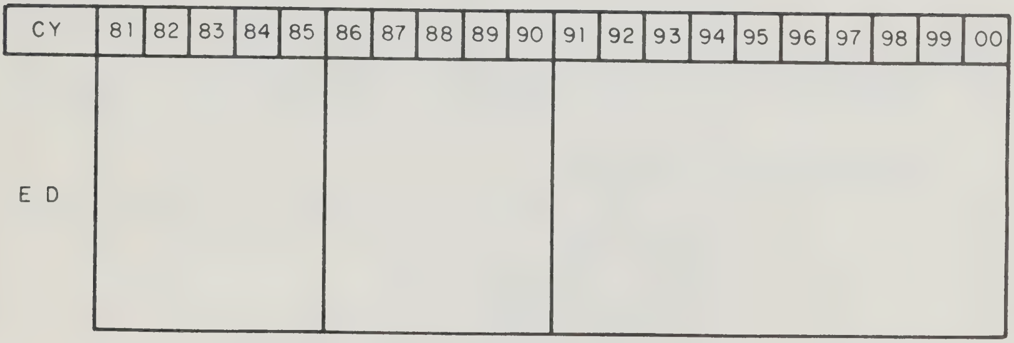
QUANTITIES: 14 Wx radars were purchased and installed by Atmospheric Environment Services - 1982-84. 22 RAMP Primary Radar Wx Channels by 1991 and possibly 6 DND ATC (TRACS) Weather Radar Channels and adjoining FAA Weather radars (NEXRAD). Possibly 13 TC WX radars 1991-2000.

RELATED PROJECTS/ACTIVITIES:

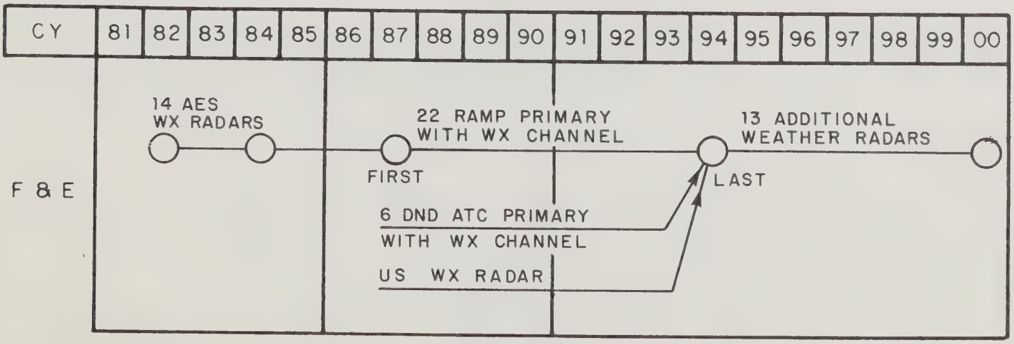
- Flight Information Services Automation
- Canadian Aeronautical Digital Network
- Radar Moderization Project
- Flight Data Systems Modernization Project
- Weather Detection, Processing and Dissemination Systems
- Flight Data Processing Investigations
- Aeronautical Information System Studies

WEATHER RADAR

SCHEDULE



SCHEDULE



PROJECT: 10. RADAR MODERNIZATION PROJECT (RAMP)

PURPOSE: To replace and modernize all ATC primary and secondary enroute and terminal radar systems. To provide modern SSR systems to replace data currently obtained from DND sites.

Replacement of existing radar systems is necessary because of decreasing data quality and availability, and increasing maintenance costs. New, solid state PSR's utilizing advanced signal processing techniques, and incorporating a weather channel along with Mode S compatible monopulse SSR systems will provide timely and accurate data to the ATC system. Through the utilization of remote monitoring and solid state electronics, maintenance workload and logistics costs will be reduced considerably.

APPROACH: Transport Canada is under contract for the provision of twenty two colocated PSR and SSR Systems, will replace existing radar systems.

Seventeen Independent SSR's, in conjunction with the colocated systems, will provide total SSR enroute coverage above 18000 feet in the high density traffic area.

Data from all new radars will be digital only. Extensive use of alternate routing will distribute the surveillance data in a reliable, cost effective manner.

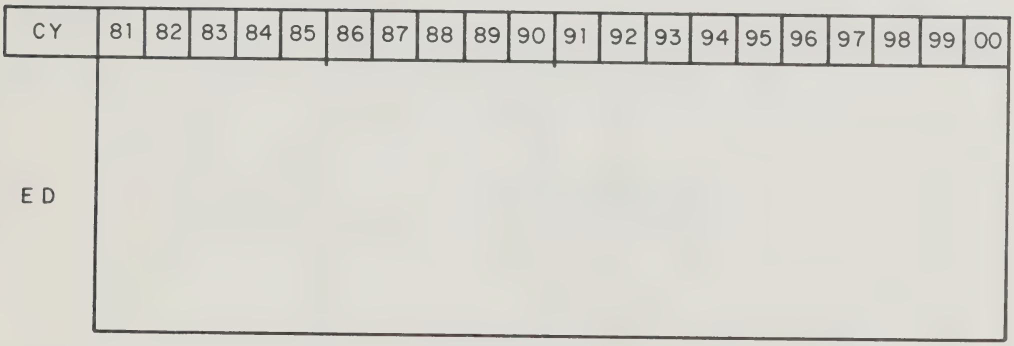
QUANTITIES: 22 colocated primary and secondary surveillance radar systems. 17 independent secondary surveillance radars.

RELATED PROJECTS/ACTIVITIES:

- Radar Modernization Project Display Site Equipment for TCUs and TWRs
- SSR Mode S Data Link Upgrade
- Weather Radar System
- Surveillance Systems Enhancements
- Development of Radar Support Facilities
- Flight Data Systems Modernization Project
- Workstation Ergonomics Studies
- Common Control Workstation
- Control and Performance Monitoring System
- Flight Inspection System Development
- Radar Data Processing System (JETS) Enhancements

RAMP

SCHEDULE



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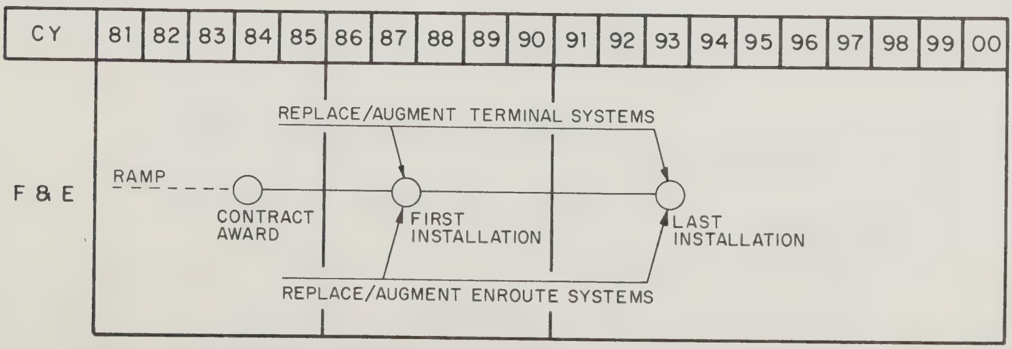


PROJECT: 11. AIRPORT SURFACE DETECTION EQUIPMENT

PURPOSE: To provide selected towers with surveillance data on the position of aircraft and vehicles on the manoeuvring area of airports. To enhance the system by providing alphanumeric aircraft identification tags on ASDE displays.

At busy airports, the monitoring of aircraft and vehicle positions, particularly in reduced visibility conditions, is required to ensure safe, and efficient operations.

APPROACH: A contract has been issued to provide for equipment and and installation of 6 ASDE's at major airports plus a training system. Deliveries of systems will begin in 1986, with the last of these being installed by 1989. The three systems presently installed will be replaced under this program. Additional systems may be required in the future as traffic demands warrant.

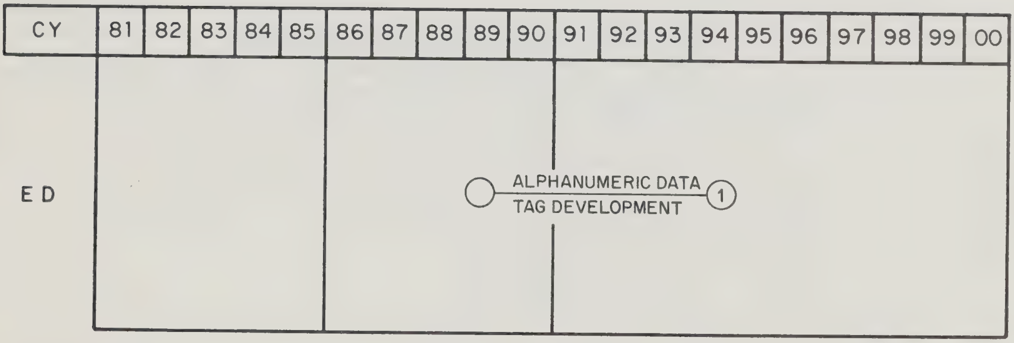
QUANTITIES: 7 ASDE's

RELATED PROJECTS/ACTIVITIES:

- Surveillance Systems Enhancements
- Development of Radar Support Facilities
- Airport Surface Navigation Development

ASDE

SCHEDULE



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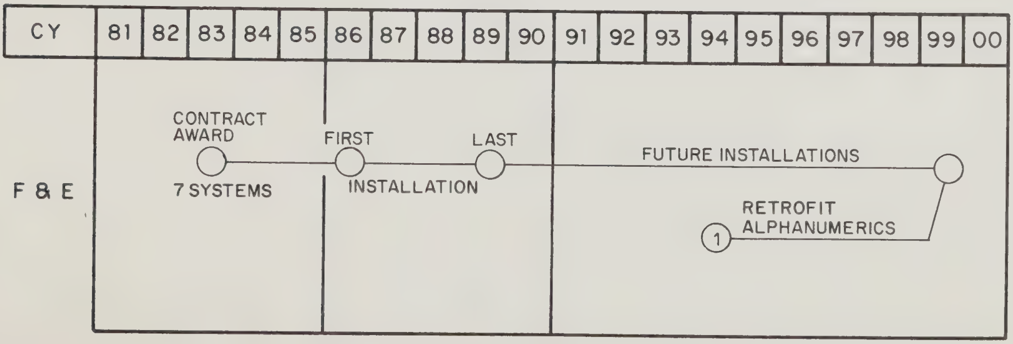


PROJECT: 12. SSR MODE S DATA LINK

PURPOSE: To provide a data link capability, using SSR Mode S, to permit automatic exchange of ATS messages, weather and automated traffic advisory information. This capability will be provided in the high density traffic area consistent with the coverage of SSR.

APPROACH: The monopulse SSR equipment will be modified to incorporate Mode S capability and thus provide a computer to cockpit data link for weather and air traffic messages. The system may also be utilized for automated ground based traffic advisory to provide aircraft separation assurance services in terminal areas. Mode S will provide improved quality surveillance data, by the elimination of interference through the discrete addressing of aircraft. Improved airborne and airport operation through digital data link services will result in increases in air traffic controller productivity.

A contract will be issued in 1990 for retrofit upgrades for all 39 monopulse SSR systems.

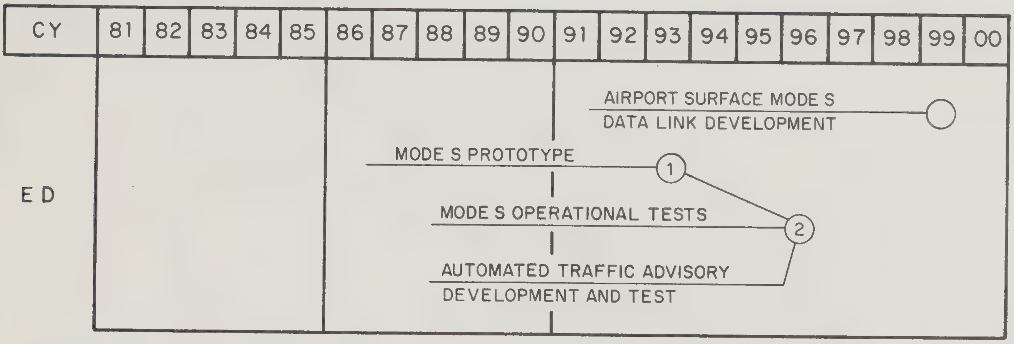
QUANTITIES: 39 monopulse-to-Mode S upgrades will be performed between 1994 and 2000.

RELATED PROJECTS/ACTIVITIES:

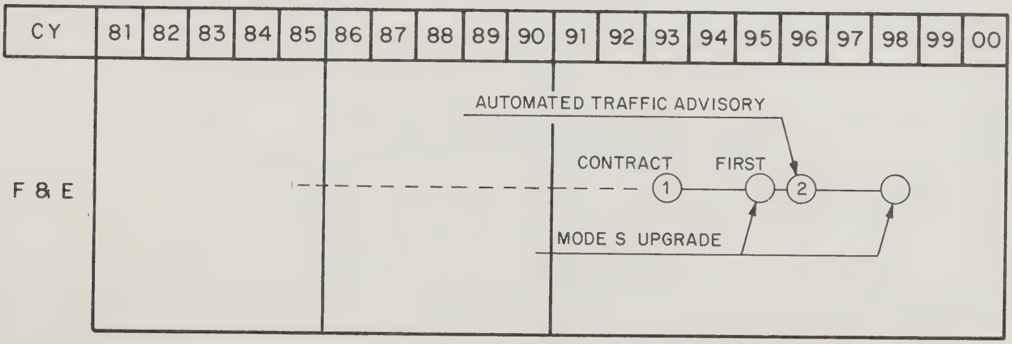
- Radar Modernization Project
- Airport Surface Navigation Development
- Advanced Air/Ground Communication and Data Link Studies
- Automatic Dependent Surveillance Investigations
- Development of Radar Support Facilities.

SSR MODE S DATA-LINK

SCHEDULE



SCHEDULE



PROJECT: 13. CONSOLIDATION OF COMMUNICATION NAVIGATION AND SURVEILLANCE FACILITIES

PURPOSE: To physically consolidate and colocate, where feasible, communication, navigation and surveillance facilities.

There are at present approximatedly 350 facility sites which can be considered for consolidation. This will result in cost savings through land use reductions, reduced maintenance travel, reduced site maintenance (heating, air conditioning, road maintenance) and reduction in inter-facility communication.

APPROACH: Consolidation is already underway where multiple communication sites exist (e.g. Edmonton ACC) and several NDB's and RCOs have been colocated. Remote communication facilities not already associated with NDB's and/or VOR's will be consolidated. Where possible consolidation of VOR and VHF-DF will be considered. New and stand-alone peripheral communication facilities will be consolidated with their associated surveillance site.

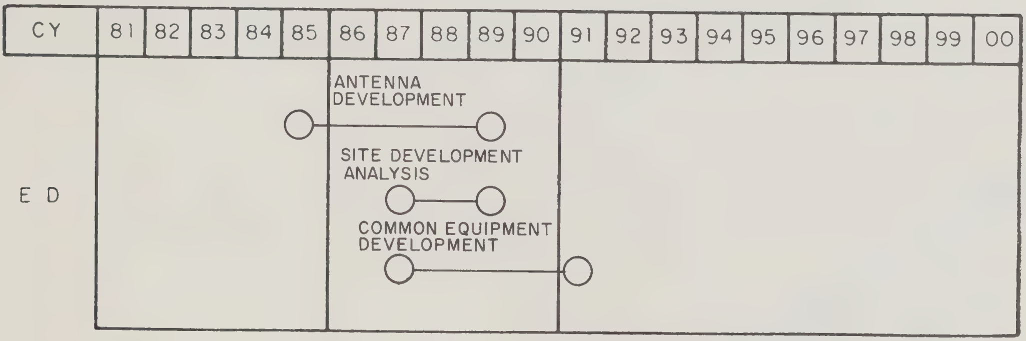
QUANTITIES: Number of facilities involved - approximately 350.

RELATED PROJECTS/ACTIVITIES:

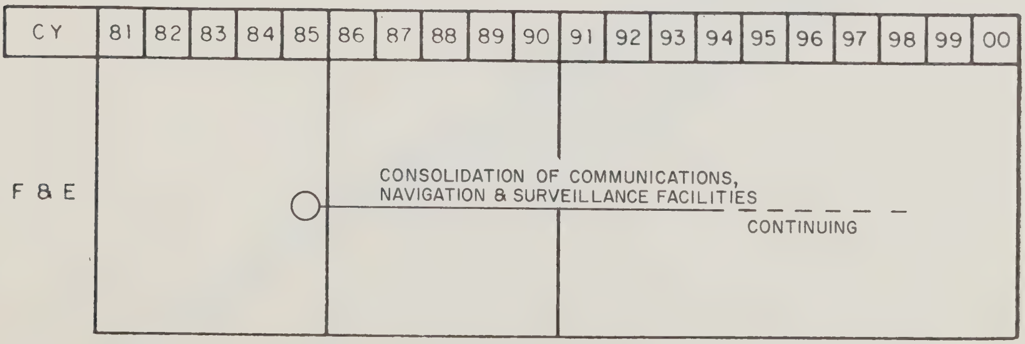
- Consolidation of Air Navigation System Facilities

CONSOLIDATION OF COM, NAV & SURVEILLANCE

SCHEDULE



SCHEDULE



CHAPTER 7

INTERFACILITY AND INTRAFACILITY COMMUNICATIONS SYSTEM

CHAPTER 7 INTERFACILITY AND INTRAFACILITY COMMUNICATIONS SYSTEMS

CONTENTS

ILLUSTRATIONS

7.1 GENERAL

Interfacility systems provide voice and data communications between all the facilites making up the Canadian airspace system. These facilities include air traffic service facilities as well as facilities such as communications, navigation and surveillance equipment sites. In addition, international communication links are provided to USA, Europe, Iceland and Greenland.

In general, dedicated circuits used exclusively by Transport Canada carry voice and/or data between facilities. Point-to-point voice grade circuits connect ATS facilities and provide links for monitoring and control of communication, navigation and surveillance sites. Networks consist of voice grade or low speed data circuits linking over 18,000 systems installed at more than 2000 sites at a leased cost over $19,000,000 annually.

Intrafacility systems provide voice and data communications within ANS facilities. These range from single circuit simple point-to-point systems to complex local area networks depending on the nature and size of the facility.

Data communications involves the combination of data source, medium, and receiver in various kinds of communications networks. The medium chosen is determined by exploring factors such as cost, speed, reliability, the availability of the medium, and the urgency of the requirements.

In the ANS system communications lines are used which could consist of one or more channels - a channel is a means of one-way communication. The direction of information flow is determined by the characteristics of the devices at each end of the channel. By using suitable terminal equipment the direction of flow along the channel can be alternated and thereby produce a half-duplex (HDX) system. If more channels are added then both way or full duplex (FDX) transmission can occur.

To send information from one point to another suitable coders and decoders, which translate data into a form that the line can handle and that the terminal devices can interpret, are used. All data communications use a binary system of codes which are made up of a number of binary digits (bits). Transmission medium capacity is usually expressed in the number of bits per second it can handle. The number of bits which make up the code limit the number of letters/characters/ symbols/-etc. that can be represented. Two commonly used codes are Baudot (5 bits) and ASCII (8 bits). Telex is a major user of Baudot but a large number of data systems rely on ASCII due to its flexibility and inherent means of error checking. The code contains 32 control characters divided into separate generic classes:

- Transmission controls used to control the flow of data along the lines.

- Format effectors used to control the physical layout of information on a printed page or on the screen of a VDU.
- Device controls used primarily for controlling auxiliary devices at the terminals.
- Information separators which logically delimit elements of data.

The control characters do not usually appear on the text but are carried as overhead on the communications system to ensure what is received is what was transmitted.

There are two basic approaches to transmitting data - parallel transmission and serial transmission. In parallel all bits of an encoded character are transmitted simultaneously along separate channels. In serial the bits of the encoded character are transmitted one after the other along one channel. Serial transmission requires the receiver to first achieve bit synchronization and then achieve character (or intelligence block) synchronization. Transmissions can be synchronous (i.e. continuous) or asynchronous whereby the receiver clock is started at the beginning of each character.

Many control and other communications characteristics are functions of the hardware/software of the transmission system and require no operator intervention. Synchronous transmissions are more efficient due to the lower number of overhead bits required. The maximum efficiency in an asynchronous system is 80%.

A good technique for increasing the efficient utilization of telecommunication links is to use multiplexers or concentrators. A multiplexer is a transparent device that divides the capacity of a communications link between a number of terminals. The two basic approaches are time division multiplexing or frequency division multiplexing. When using multiplexers each terminal thinks it has a point-to-point relationship with other terminals.

A concentrator (or communications processor) is a computer based device that usually has some form of mass data storage. Because it alters the form of a data stream, it can be interfaced to a varied network ranging from low speed asynchronous lines, through medium speed synchronous and asynchronous lines, to high speed applications. The concentrator, by handling part of the telecommunications network functions, can take some load from a central communications processor or even a host computer. Concentrators on complex networks are sometimes referred to as nodes. If a concentrator is equipped with sufficient storage, it can act as a store and forward device in that it will assemble complete messages or blocks of messages, store them in memory, and then forward them to their proper destination. A concentrator can be used to perform code, speed, and format con-

versions, thereby accommodating a spectrum of different terminals from a network.

The concentrator and the multiplexer represent two different degrees of telecommunications capability. In between are devices with varying functions that are usually referred to as "intelligent multiplexers".

A data communications network can be a simple collection of terminals, lines, and computers or it can be a complex system with hundreds of terminals and many computers connected across thousands of kilometers.

There are four basic network configurations that can be used:

- The STAR network whereby each terminal is connected to a central site by a point-to-point single terminal line, multi-drop lines, or smaller STAR networks. To lower line costs a STAR network using multi-drop (or multi-point) lines can be used whereby two or more terminals are connected to one line. Because terminals cannot transmit simultaneously, line control procedures are necessary such as polling in which the central site invites the terminals, in an orderly fashion, to transmit data. Each terminal has a receiver which recognizes only it's address and responds to that address, ignoring all others. The STAR network is entirely dependent on the integrity of the central site. If two terminals wish to communicate they must do so through the central site.

- The RING network which consists of a number of computers (or concentrators) connected together in a loop or ring. In this way a single path can be established along separate routes and if any one path fails another link will be available.

- The MESH network is an expansion of the RING network which interconnects many cities and many terminals. The deciding factor to establish a MESH network include line costs, geographical distribution of the data interchange requirements, and the volume of data to be distributed throughout the network.

- The HIERARCHIAL network which uses various levels of computers and concentrators connected in a similar way as a government organizational chart.

In many applications terminals may need to transmit data for relatively short times in a day so use can be made of various switched networks. These networks enable the establishment, on demand, of a point-to-point connection between two terminals. This connection is maintained as long as needed. The telephone network is a good example of a switch network.

7.1 GENERAL Cont'd

In designing the network tradeoffs are made between reliability, efficiency and costs with the result that any one system may contain different types of networks.

Although most interfacility systems are leased, some are owned by the Aviation Group. Systems owned by the Aviation Group are either radio links (microwave for radar data or UHF/VHF for remote monitoring, control and operation) or cable distribution systems on airports (for example for ILS remote monitoring, control and operation). Within each operational unit there are several intrafacility systems consisting of voice or data local area networks for each sub-system. These local area networks (as used by systems such as the ICCS, JETS, OIDS, etc.) are not interlinked at the present time.

The leased services are provided by the major common carriers for national and international sytems and the local common carriers for local regional circuits. Canada fulfills its commitment to the world-wide Aeronautical Fixed Telecommunication Network (AFTN) with a low speed teletype domestic network called the Automated Data Interchange System (ADIS). ADIS interfaces internationally with a circuit to the USA and several circuits to Europe, Iceland, and Greenland. ADIS is also interconnected to the centralized automated NOTAM system. The present AES Meteorological teletype network, for the most part, parallels the ADIS network but is not interconnectable to ADIS. Present day voice and data communication networks have been implemented for specific service functions and are not interconnectable. Short distance, point-to-point circuits (such as the cross-border circuits to the USA) have proliferated over the years in an attempt to solve local operational problems.

Most ADIS circuits are low-speed 300 bits per second (bps) or less. Medium speed data circuits (1200-9600 bps) link the FAA and Canadian AFTN switches at Kansas City and Montreal. Digitized radar data for input to automated systems (such as JETS) use circuits at bit rates of 2400 bps. One optical fibre circuit connects the two air terminal buildings at Toronto International Airport for the passing of security and airport operational information. Other fibre optic circuits are used for the Airport Surface Detection Equipment (ASDE).

Interfacility and Intrafacility Systems evolved over time as requirements dictated and technology allowed. Leased circuit costs were low, thereby resulting in the proliferation of single-user circuits along parallel paths. Leased services were generally provided by the Common Carriers. Continuing to provide inter- and intrafacility systems as in the past will increase costs to the ANS system at an unacceptable rate because basic circuit costs are escalating, competition is not being fully utilized and the new technology is not being exploited.

7.2 THE NEW APPROACH

A total systems approach will be taken in the future development and implementation of the Interfacility and Intrafacility communications system.

In order to constrain costs and to provide operating flexibility, communications networks will be combined to the greatest extent possible through the use of distributed switching intelligence and other modern techniques. Transition to the future systems will be evolutionary and the first step will combine the data networks into an integrated system called the Canadian Aeronautical Digital Network (CADIN). The digitization of voice will allow voice interfacility systems to be integrated into the CADIN. CADIN will include distributed communications computers (intelligent nodes) with high speed links interconnecting the major ATS facilities and medium speed links interconnecting the FSS hubs, remote FSS and the remote navigation aid, communication and surveillance sites.

Intrafacility communications requirements will utilize the inherent redundancy of local area networks employing distributed processing techniques. This approach will result in a more highly fault-tolerant system than previously possible with single or dual processor configurations. Because of the intrinsic modularity of distributed sytems, expansion will be facilitated permitting upgrading or additions.

7.3 EVOLUTION OF THE SYSTEM

CURRENT PROGRESS (TO 1985)

In order to establish a foundation for network evolution to CADIN, activities are underway to upgrade system performance with emphasis on constraining costs.

A study into facsimile usage within the Aviation Group has recently been completed. The old analogue facsimile machines have been replaced by modern digital machines which can be easily networked at a reasonable cost and work is underway to accomplish this.

Most communications links are short-haul point-to-point and join ACC's, TCU's and FSS's to remote sites or to each other. They are normally leased on a piecemeal basis in accordance with published tariffs. The number of lines required has been decreased through the use of time division multiplex equipment where both control and voice are needed. Some savings have been realized through the competitive bulk leasing of voice grade lines. Increased savings will be realized from the first TC point to point satellite link which has now been installed between Montreal and Kuujjuaq in Northern Quebec.

7.3 EVOLUTION OF THE SYSTEM Cont'd

The pushbutton telephone equipment installed up to 25 years ago and now almost impossible to maintain, has been replaced at most towers, TCUs and FSSs. Plans are being formulated to integrate these functions into the next generation of communication control equipment.

The ADIS message switching computer was upgraded in 1985. This permits enhanced message formatting, flexibility of message handling and the inclusion of new message traffic-types such as weather information and flight plan data. The network is being reconfigured to include higher speed circuits to the major ATS centres. The switch is now connected to Kansas City but it will eventually operate to Salt Lake City when the FAA National Data Interchange Network becomes operational. The weather information provided to and from AES will be carried on ADIS thereby eliminating the duplication of circuits that now exist. The reconfiguration of the network will be completed by the end of 1986.

The present centralized semi-automated NOTAM system which utilizes the ADIS/AFTN network, enables the on-line collection, distribution and bulletin preparation of NOTAM information and provides automatic request/retrieval capability to authorized users. The system is being upgraded to allow an international data base update.

NEAR TERM (TO 1990)

There will be significant changes as the ADIS evolves into a general purpose data transmission system with alternate routing capabilities to bypass failed or saturated areas. Local communications processors with links to remote sites will be established in each flight information region to complement the central communications switch. These processors will allow direct communications between ATS facilities within an FIR without having to pass all data through the central communications switch. ADIS will be designed to utilize whatever transmission medium proves to be the most cost effective. This network will become the backbone to the entire interfacility communications system.

Multiplexed circuits will be used to connect multiple remote points to the network's backbone. Directing low speed circuits into high capacity lines that transmit and receive numerous messages simultaneously (multiplexing), allows facilities requiring access to the network to do so in a cost-effective manner and eliminates a large percentage of individual lines.

Under the CPMS project remote maintenance monitoring will begin to be implemented with data transfer via the most cost-effective means.

7.3 EVOLUTION OF THE SYSTEM

Communications control equipment capable of carrying both voice and data will be installed at TWR's, TCU's and FSS's in the late 1980's. These systems will consolidate the single-user intrafacility circuits at these places into multipurpose local networks. Separate data and voice lines will still be needed for interfacility purposes during this transition period but the basis for a complete communications network will be established. Development work will be underway on the digitization of voice which, when evenly implemented, will allow widespread integration of voice and data communications. The total network will encompass the backbone, the local short haul point-to-point links and the local area networks thereby allowing facility consolidation and other activities requiring cost-effective telecommunications to proceed.

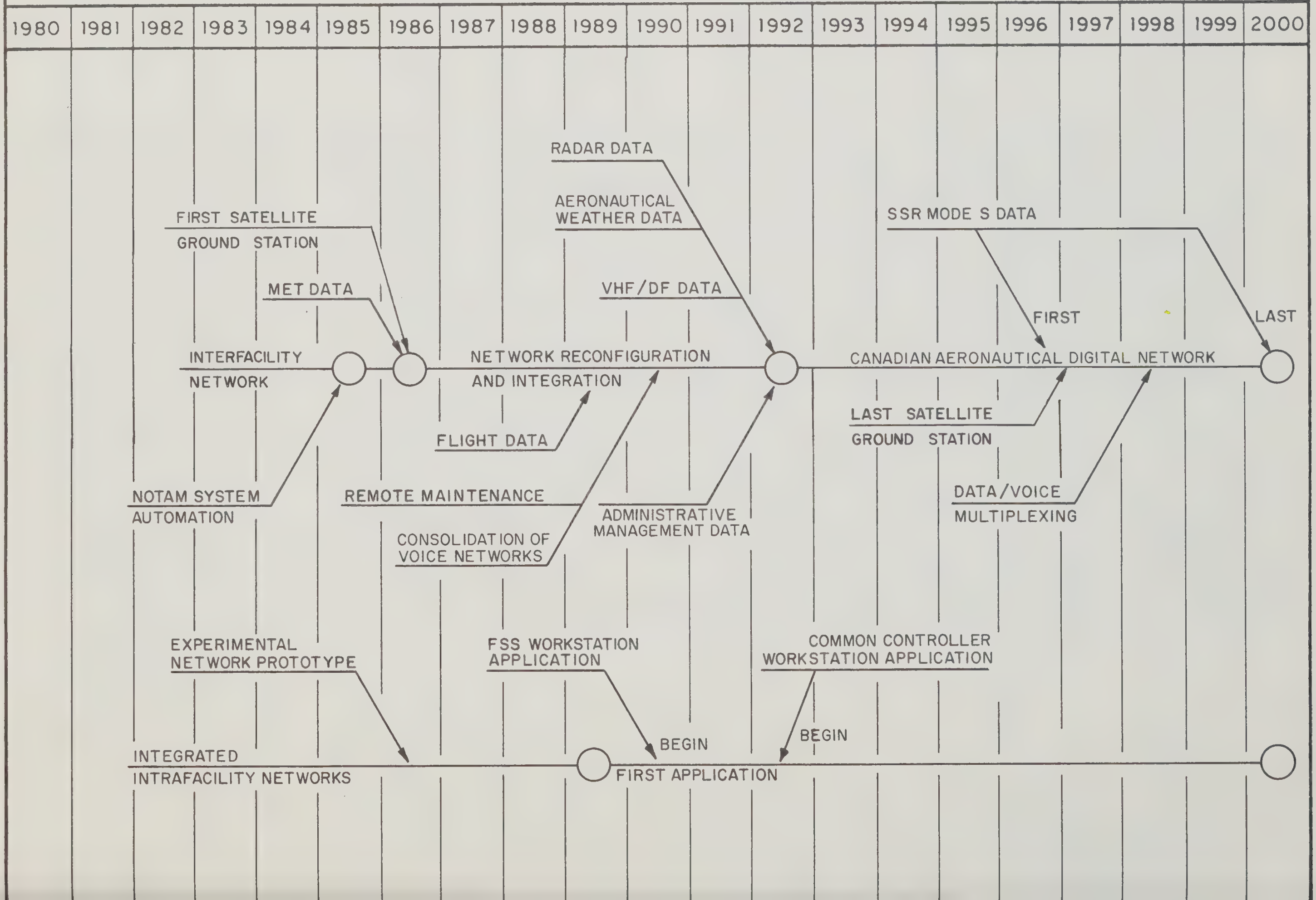
During this period the transmission media will be a mix of terrestrial and satellite circuits. Due to the geographic characteristics of Canada and the predominent east-west concentration of high capacity terrestrial links, multiplexing the north-south telecommunications circuits into satellite trunks will become more common. A project will be initiated to procure satellite ground terminals for Transport Canada use.

LONG TERM (TO 2000)

In the long term as more facilities are consolidated, as SSR Mode S and data-linked dependent surveillance are introduced and as more automated stations are installed, increasing interfacility requirements must be accommodated. Digitized voice and data will be integrated into the distributed Canadian Aeronautical Digital Network (CADIN). The redundancy built into the network will ensure high reliability and availability.

Transmission media and technologies are likely to change within this period. Continuing analysis of need and detailed investigations will occur to take into account the increased efficiency and reduction in costs that the use of such media may bring.

FIG. 7.1. INTERFACILITY AND INTRAFACILITY COMMUNICATION SYSTEM EVOLUTION



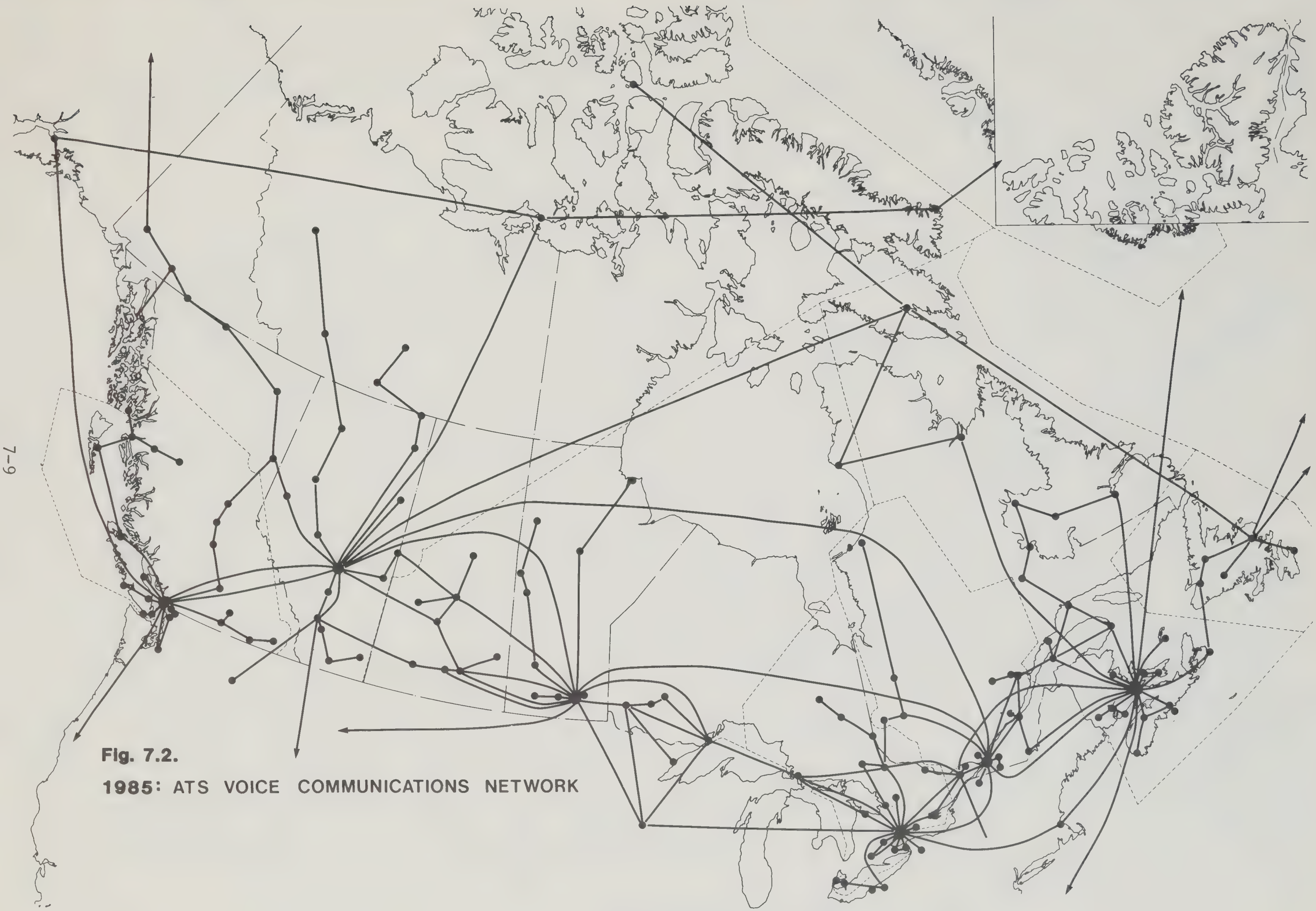


Fig. 7.2.
1985: ATS VOICE COMMUNICATIONS NETWORK

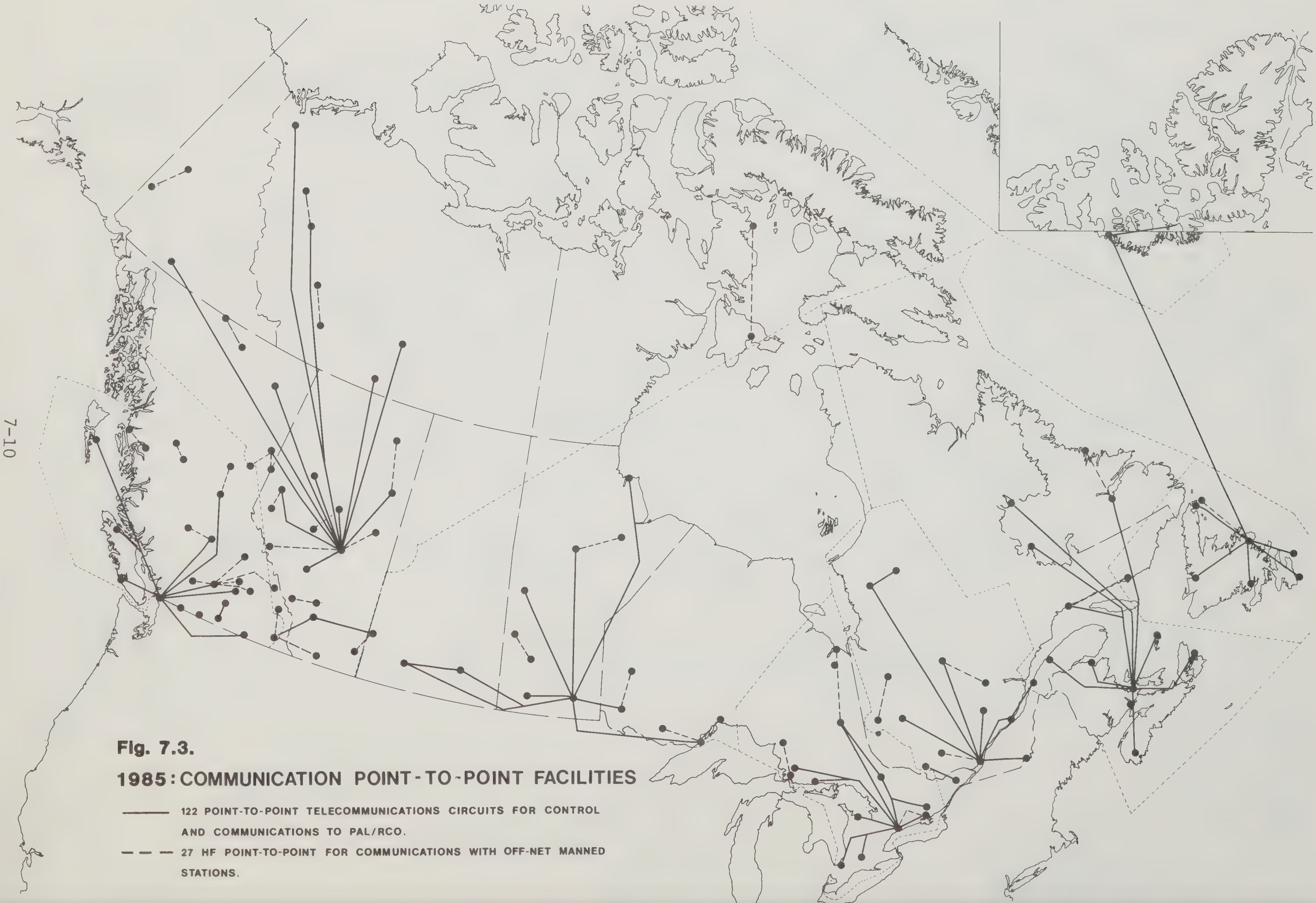


Fig. 7.3.

1985: COMMUNICATION POINT-TO-POINT FACILITIES

——— 122 POINT-TO-POINT TELECOMMUNICATIONS CIRCUITS FOR CONTROL AND COMMUNICATIONS TO PAL/RCO.

— — — 27 HF POINT-TO-POINT FOR COMMUNICATIONS WITH OFF-NET MANNED STATIONS.

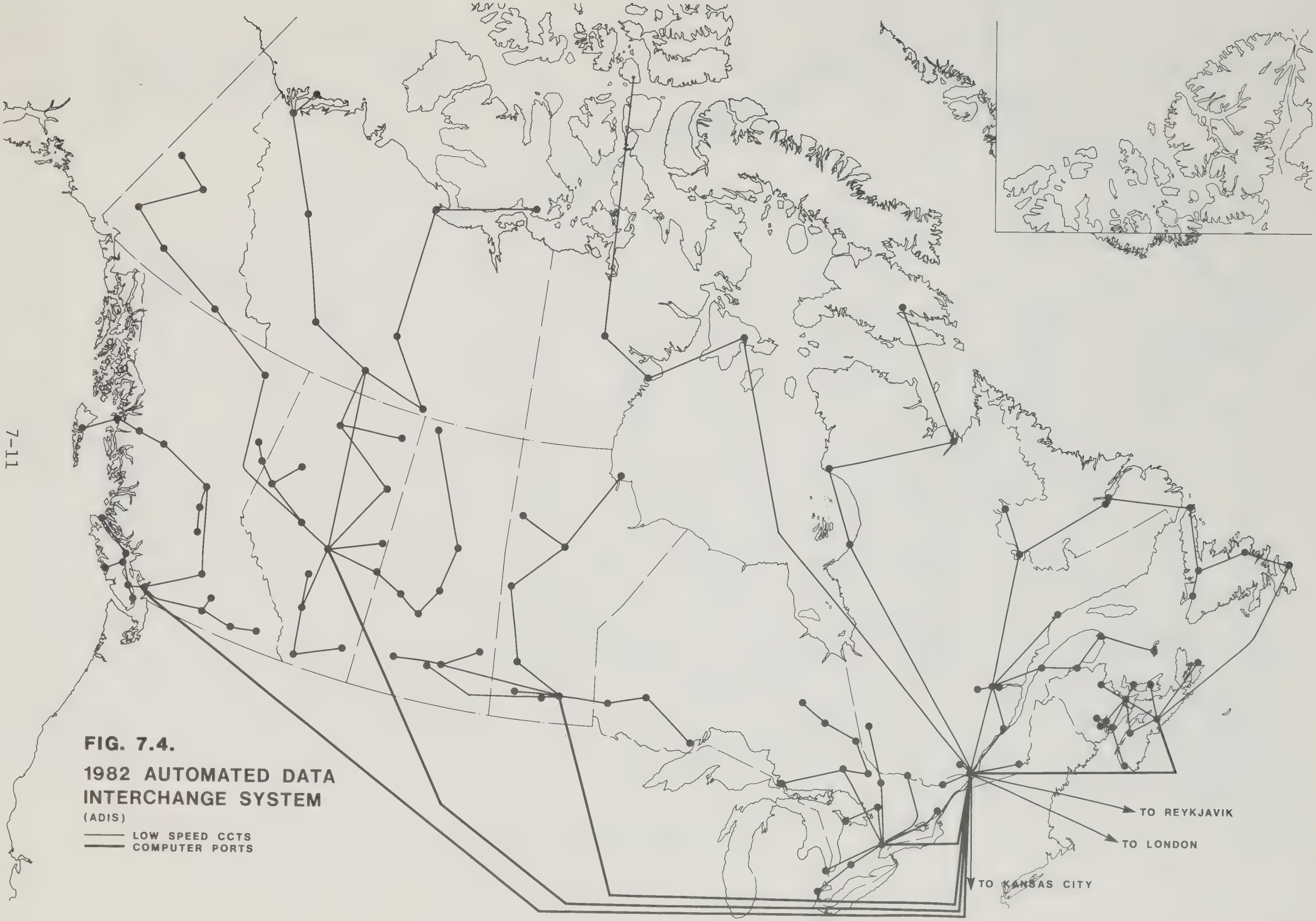


FIG. 7.4.

1982 AUTOMATED DATA INTERCHANGE SYSTEM

(ADIS)

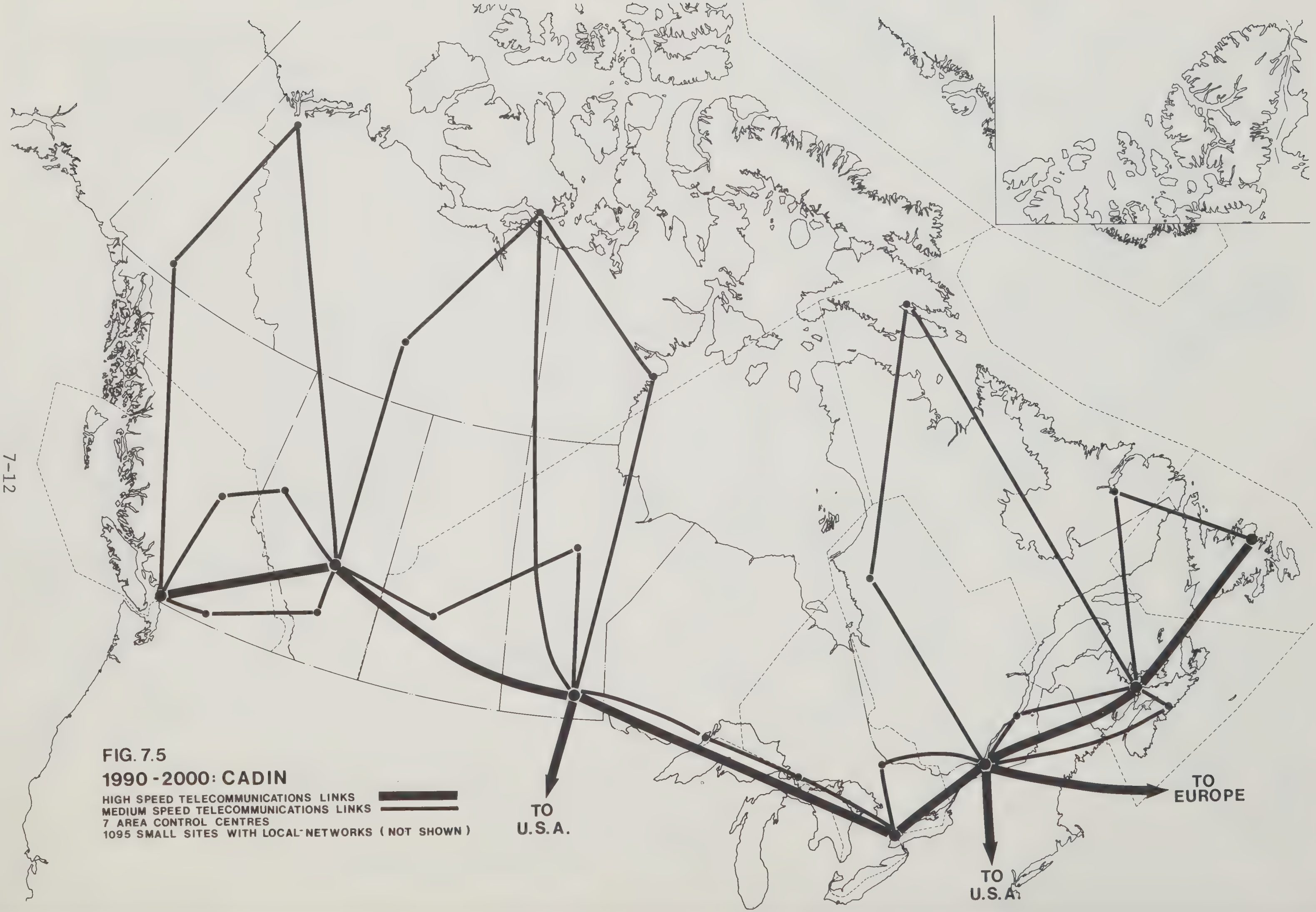


FIG. 7.5

1990 - 2000: CADIN

7.4 INTERFACILITY AND INTRAFACILITY COMMUNICATIONS - PROGRAM OF PROJECTS

PROJECT	IMPLEMENTATION 1st	IMPLEMENTATION Last
INTERFACILITY COMMUNICATIONS		
1. Satellite Ground Stations	1985	1997
2. NOTAM System Automation	1983	1985
3. Network Reconfiguration and Integration	1984	1992
4. Canadian Aeronautical Digital Network (CADIN)	1992	2000
INTRAFACILITY COMMUNICATIONS		
5. Integrated Intrafacility Networks		
(a) Small Systems	1986	1996
(b) Large Systems	1991	1997

PROJECT: 1. SATELLITE GROUND STATIONS

PURPOSE: To acquire satellite ground stations for point-to-point voice/data fixed communications purposes.

APPROACH: A trial system has been installed in Quebec Region to serve as a Peripheral circuit (PAL) between Montreal ACC and Kuujjuaq in northern Quebec. The system is being evaluated to ensure it meets all operational requirements. Upon successful completion of the evaluation, a program to lease/purchase additional ground stations to replace existing facilities where the satellite solution is most cost effective will be initiated.

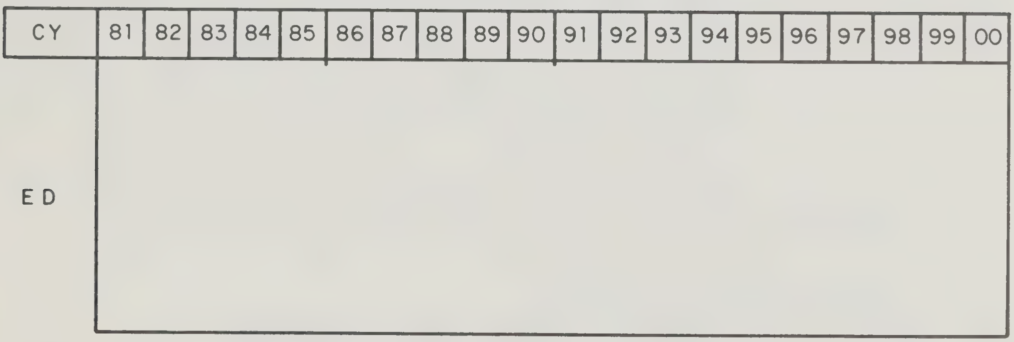
QUANTITIES: As of 1 January 1986, thirty-eight locations have been tentatively identified as meeting the cost benefit requirements. Ongoing analysis will identify additional locations and uses as the network expands.

RELATED PROJECTS/ACTIVITIES:

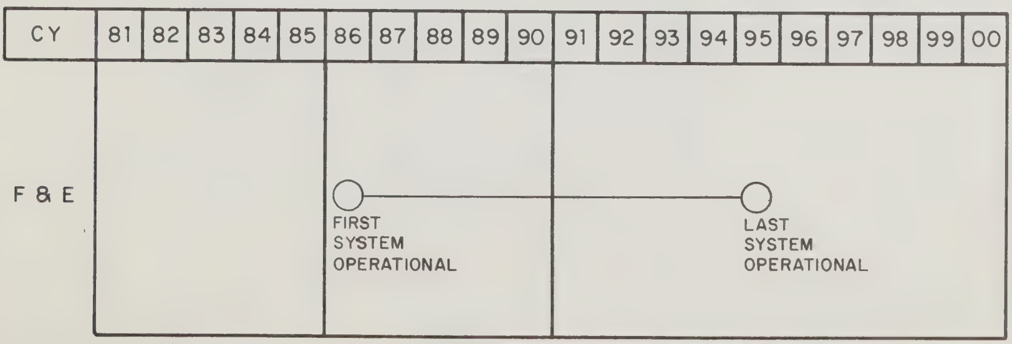
- Radar Modernization Project
- Flight Data Systems Modernization Project
- Flight Information Services Automation
- Aeronautical Information Processing System
- Multi-Purpose Information Display System
- Aviation Weather Processors
- Control and Performance Monitoring System
- Speech Processing and Transmission Systems Development
- Telecommunications Networks Investigations
- Automatic Dependent Surveillance Investigations
- Weather Detection, Processing and Dissemination Systems
- Aeronautical Information System Studies
- Canadian Aeronautical Digital Network

SATELLITE GROUND STATIONS

SCHEDULE



SCHEDULE



PROJECT: 2. NOTAM SYSTEM AUTOMATION

PURPOSE: To upgrade the present automated Notices to Airmen (NOTAM) system which caters only to domestic NOTAM's, into a fully integrated request/reply database capable of being interrogated by all users of domestic and international NOTAM's.

NOTAMS are essential to the safety of flight because they provide information on abnormal conditions or outages to ANS and airport services that exist. They are also time critical. At present, users that require NOTAM's outside of their normal area of coverage request this information from the central NOTAM Office database. The reply however, contains only information on Canadian facilities. Required information on international (foreign) facilities must be manually compiled and transmitted separately by the NOTAM office staff.

The aim of the project is to enhance services to aviation and improve person-year utilization by providing automatically all of the desired information.

APPROACH: The old terminals have been replaced. Software improvements to permit full automated operation have been implemented. In the automated systems operator intervention will only be required for verification of NOTAM accuracy or if an unusual situation develops. Additional storage capacity has been obtained to accommodate the international data base which will become operational early in 1986. It is intended to lease the system until at least 1988.

QUANTITIES: One dual system colocated with the ADIS switch in Montreal.

RELATED PROJECTS/ACTIVITIES:

- Flight Information Services Automation
- Network Reconfiguration and Integration.
- Aviation Weather Processors
- Aeronautical Information Processing System.
- Canadian Aeronautical Digital Network
- Flight Data Systems Modernization Project
- Control and Performance Monitoring Systems
- Aeronautical Information Systems Studies
- Telecommunications Networks Investigations
- Workstation Ergonomics Studies

NOTAM SYSTEM AUTOMATION

SCHEDULE

CY	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00
E D																				

SCHEDULE

CY	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00
F & E			IMPLEMENTATION			INTERNATIONAL DATA BASE OPERATIONAL														

PROJECT: 3. NETWORK RECONFIGURATION AND INTEGRATION

PURPOSE: To reconfigure the existing data network, economically provide improved services, provide for future expansion, improve reliability and survivability and reduce leased line requirements. This project will result in an integrated data network.

The present ADIS network consists of 64 low speed (300 bit per sec or less) single drop or multi-point ASCII teletype circuits fanning out from a central switch located in Montreal. One medium speed line (1200 bit/sec) circuit links Montreal to the Kansas City AFTN switch.

If we continue to provide the data communications as we have in the past then the costs to the ANS system will increase at an unacceptable rate because basic circuit costs are escalating, competition is not being fully utilized, and the new technology is not being exploited.

APPROACH: The existing network was upgraded to 300 baud to take advantage of the capability of the new ADIS switch to implement higher capacity links on some overloaded circuits. The network will be reconfigured in 1986, but will still use the central switch.

The AES network to ATS facilities will be eliminated and all required aviation weather information will be carried on ADIS by the end of 1986.

The future system design will be based on the projected data requirements for the enroute and terminal, air/ground, FSS, and aviation weather system. Message switching techniques will be used until at least 1988.

This project is a prerequisite to the Canadian Aeronautical Digital Network (CADIN.)

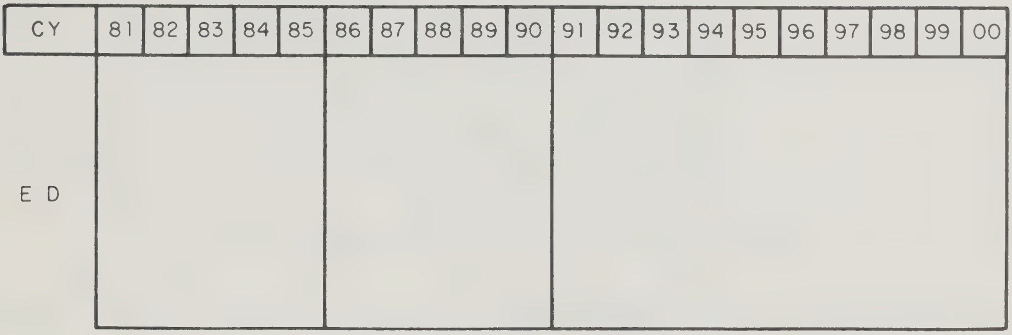
QUANTITIES: Enhancement and expansion of the present ADIS Network.

RELATED PROJECTS/ACTIVITIES:

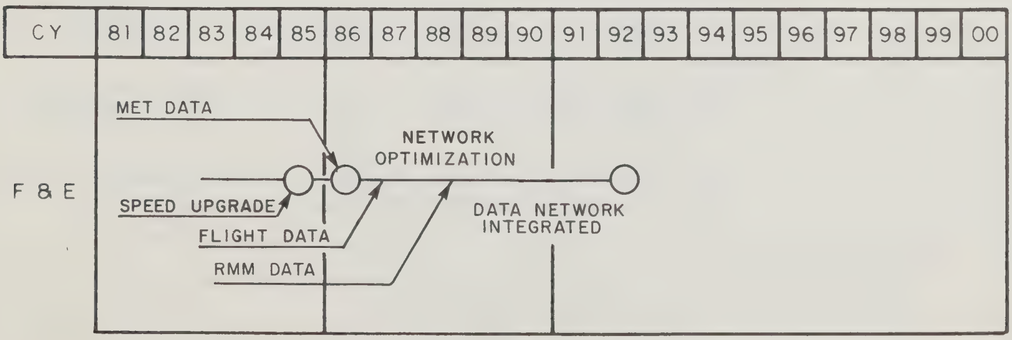
- Flight Data Systems Modernization Project (FDMP)
- Flight Information Services Automation
- Aviation Weather Processors
- Radar Modernization Project
- Multi-Purpose Information Display System
- Control and Performance Monitoring System
- Aeronautical Information Processing System
- Canadian Aeronautical Digital Network
- Telecommunications Networks Investigations
- Weather Detection, Processing and Dissemination Systems
- Aeronautical Information Systems Studies

NETWORK RECONFIGURATION AND INTEGRATION

SCHEDULE



SCHEDULE



PROJECT: 4. CANADIAN AERONAUTICAL DIGITAL NETWORK

PURPOSE: To provide an efficient, cost-effective, integrated, common user network to replace the ADIS.

In addition to the data carried by ADIS, the increased requirements stipulated in the Canadian Airspace Systems plan, the ICAO planning for the Common ICAO Data Interchange Network (the future evolution of the AFTN), the digitization of the voice networks, and future unforseen requirements necessitate a complete upgrade of the interfacility system to the CADIN.

As CADIN evolves into an all encompassing digital communications network it will provide the required flexiblity and interoperability demanded by the Canadian airspace system. The alternative of dedicated independent lines will not provide the above capability and would be prohibitive in cost.

APPROACH: A highly connected, code and byte independent, switched network with virtual circuit and alternate routing capability will be implemented to initially accommodate the data communications needs. As work progresses on the digitization of voice systems they will be integrated into CADIN. A centralized network control and monitoring facility will be established. Standardization of access interface and an appropriate protocol based on ISO Standards will be maintained to ensure future flexibility and evolution of the system. Message switching will continue to be provided for quick response, interactive data transfer and efficient file (data base) transfer capability. Nodes and concentrators will be added as required.

The following activities will occur:

- Engineering Development for networking, leading to design and specification.
- Implementation of nodes and added trunking.
- Implementation of additional capacity, connectivity and interfaces.
- Continued Engineering Development during the evaluation of the system.
- The possibility of switching off peak hour administrative communications via CADIN will be investigated.

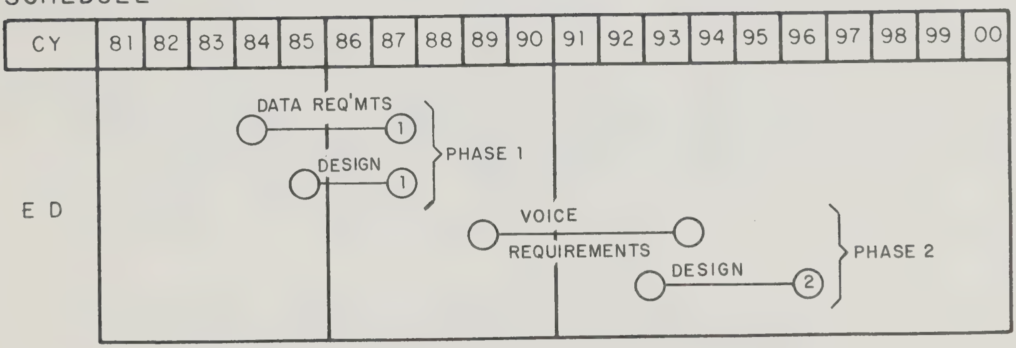
QUANTITIES: Communications processors will be added as required. There will be at least one per FIR.

RELATED PROJECTS/ACTIVITIES:

- Radar Modernization Project
- Flight Data Systems Modernization Project
- Flight Information Services Automation
- Aeronautical Information Processing System
- Multi-Purpose Information Display System
- Aviation Weather Processors
- Control and Performance Monitoring System
- Speech Processing and Transmission Systems Development
- Telecommunications Networks Investigations
- Automatic Dependent Surveillance Investigations
- Weather Detection, Processing and Dissemination Systems
- Aeronautical Information Systems Studies
- Consolidation of Communications, Navigation and Surveillance Facilities

CADIN

SCHEDULE



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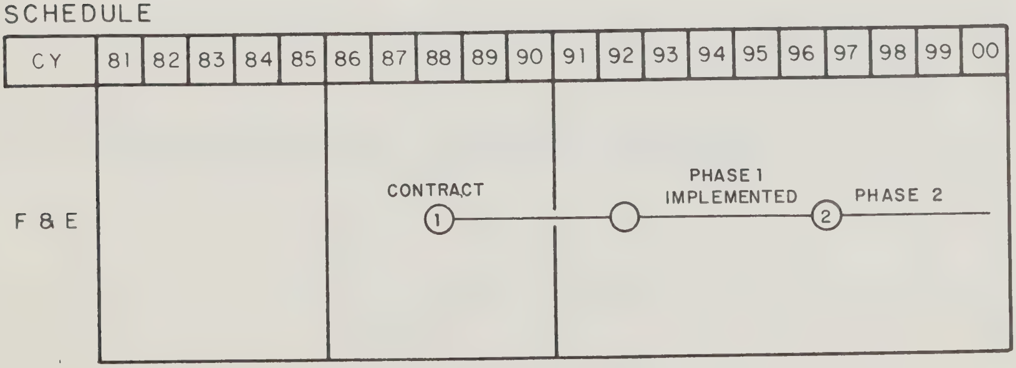


PROJECT: 5. INTEGRATED INTRAFACILITY NETWORKS

PURPOSE: To provide ATS facilities with cost effective, flexible, fault-tolerant intrafacility communications (voice and data) systems based on local area network concepts.

Because ATS operational systems play a critical role in air safety these intrafacility systems must be highly reliable both from the point of view of low number of equipment failures and high data integrity. The high cost of intra facility systems also dictates that they be readily expandible thereby avoiding early obsolescence due to loading beyond the initial network capacity.

The inherent redundancy of local area networks employing distributed processing techniques should result in a more highly fault-tolerant system than previously possible with single or dual processor configurations. Because of the intrinsic modularity of distributed systems, expansion will be facilitated, permitting upgrading or additions.

APPROACH: Engineering development being conducted on distributed systems identified approaches for the implementation of reliable and flexible systems, based on local area networks.

As part of this investigation, an experimental local area network integrating both voice and data has been established to assess commercially available software with regards to its applicability to ATS systems and to identify future software development needs. The concepts defined in the investigation phase will be proven through simulations on a prototype system. These engineering development activities are expected to continue until 1987.

Partial integration of these intrafacility networks into operational systems will begin in 1987. Full implementation in an evolutionary manner will continue through the turn of the century.

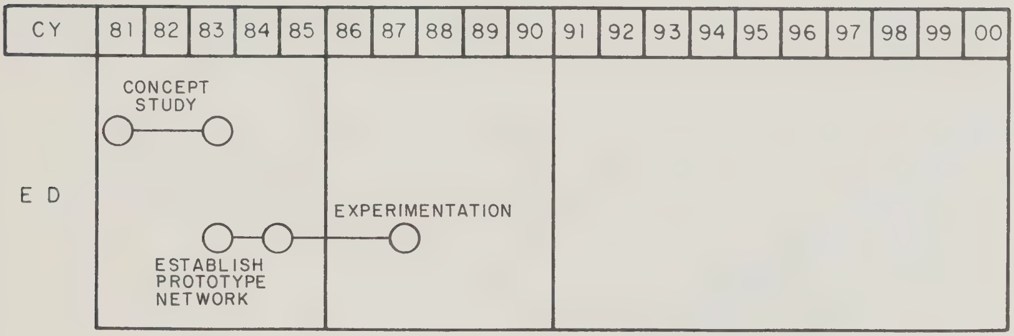
QUANTITIES: At least one per ATS facility.

RELATED PROJECTS/ACTIVITIES:

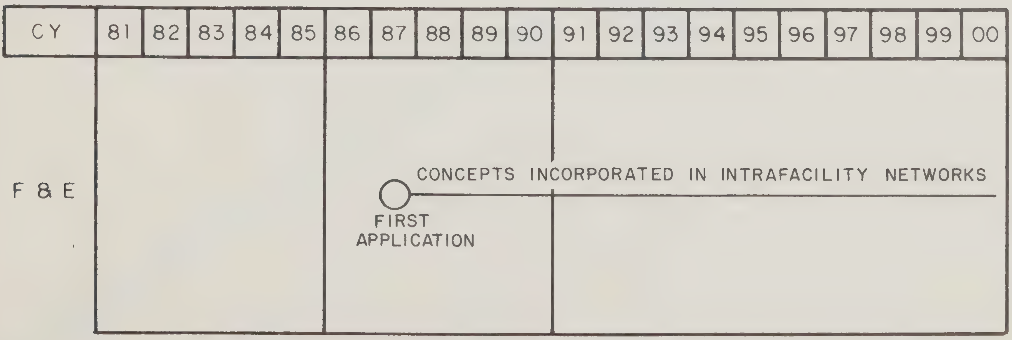
- This project will have an impact on all ATS computer based systems.

INTEGRATED INTRAFACILITY NETWORKS

SCHEDULE



SCHEDULE



CHAPTER 8

MAINTENANCE AND SUPPORT SYSTEMS

CHAPTER 8 — MAINTENANCE AND SUPPORT SYSTEMS

CONTENTS

ILLUSTRATIONS

FIG.

8.1 GENERAL

Maintenance and support systems include those auxiliary systems which are necessary for ensuring the continuing evolution, operation and performance of the Canadian Airspace System. These functions support the system as a whole, as opposed to supporting a specific individual system. This chapter focuses on the maintenance program and the support functions of flight inspection, technical training, technical support and security.

8.2 MAINTENANCE

A maintenance program is essential for ensuring the continual operational performance and integrity of the whole Canadian Airspace System. The maintenance activities resulting from the program are dependant on highly skilled technicians following established maintenance procedures. For administrative purposes these activities are organized geographically into six Regions. Each Regional Office provides technical administration and field maintenance management. In the field, maintenance is divided into centres, each centre being under the direction of an Electronics Centre Manager (ECM). Within a centre, equipment is located at manned or unmanned stations.

Currently, procedures are primarily based on preventative maintenance, which require checks to equipment on a scheduled basis. Currently installed equipment requires frequent site visits, resulting in a labour intensive use of maintenance personnel. However, the replacement of tube-type equipment with new solid-state equipment is enabling the periods between maintenance visits to be significantly increased. This, together with the application of remote maintenance monitoring techniques to some of the more isolated facilities, is currently helping to reduce maintenance travel with some offsetting of person year growth.

While the improved reliability of electronic equipment provides the potential for saving through the reduction of site visits, the unreliability of electrical power compromises efforts to achieve such savings. Basic electrical power is usually provided from a commercial source, but the possibility of failure requires that such prime power be backed up on-site by standby power systems. Steps are being taken now to improve the reliability and availability of electrical power and reduce the maintenance of associated power sources. Other possible means of providing prime and back-up power in the future are being investigated.

8.3 FLIGHT INSPECTION

Flight inspection activities are an integral part of the maintenance program for communications, navigation and surveillance facilities and essential to the authorizing of these facilities for operational use.

Flight inspection encompasses:

- Confirmation that communications, navigation and surveillance systems are acceptable for operational use (about 4500 flying hours yearly).

- Calibration and inspection of new navigational aids prior to commissioning.

- Assessment of new sites.

- Calibration and inspection of a facility performance after major maintenance or refurbishing.

Currently, new flight inspection equipment and procedures are being introduced to increase the speed and efficiency with which facilities can be evaluated. Two high speed jet aircraft and two turbo-prop aircraft have been delivered. Analysis has shown that the high speed aircraft, operating efficiently at higher altitudes and speeds, will enable the more distant and spread-out facilities to be inspected in less time and in fewer flights, while the use of turbo-prop aircraft, though slower, will optimize the service provided when long periods of flight are required at lower altituides.

The Digital Flight Inspection System (DFIS) in conjunction with a Self Contained Aircraft Positioning Equipment (SCAPE), which will be fitted in these aircraft, will eliminate the need for ground theodolite personnel during flight inspections and will provide a weather-independent flight inspection capability. The equipment records all measurements and, because of the on-board computing capability, will be able to assess the results in-flight. The DFIS is certified in the high-speed aircraft (and in the turbo-prop aircraft during 1986). As certification is completed these aircraft will replace the remaining eight older flight inspection aircraft so that by July, 1986 the flight inspection fleet will be reduced to two high-speed and two medium-speed aircraft and the number of bases will have been reduced from seven to one base in Ottawa.

SCAPE certification will continue through 1986. Completion is anticipated by the end of the year and will not affect the implementation date of the National Flight Inspection program. The need for a permanently manned Western base will be reassessed in 1987.

Development of the operational performance and assessment functions for MLS and communications and surveillance systems are underway. Additionally, evaluation of electro- magnetic interference and methods to improve the calibration of aircraft antenna systems will be undertaken.

8.4 TECHNICAL TRAINING

About 60% of the training of the technical staff is carried out at the Transport Canada Training Institute (TCTI), Cornwall. Technical training includes instruction on computer-based systems, navigation aids, communications, radar systems, security systems, and aircraft avionics. Technical training not carried out at TCTI is provided through contracts, manufacturers courses, on-the-job training or field training programs.

8.5 TECHNICAL SUPPORT

The Aviation Group is responsible for the engineering development, design, procurement, maintenance and operation of all telecommunications electronics equipment and computer-based equipment for the Canadian airspace system. Technical support is provided through two major facilities:

- A Technical Systems Centre, which provides an environment for designing, developing and testing electronic devices and systems. It will also house the test bed systems and maintenance support facilities used by the engineering divisions in providing field support and configuration management for computer-based systems in operational use across Canada.

- A Research and Experimentation Centre (R & E Centre), which provides facilities to simulate and evaluate the work environment of air traffic controllers and thus provides the means for investigating new procedures and methods of controlling air traffic.

Various management information systems are used to keep track of plant, as well as to provide management with both historical and day-to-day operational information relating to the performance of the Canadian airspace system. Such information is vital for efficient management of the system and for conducting trend analysis relating to the maintenance of equipment. Presently there is no interrelationship between the various management information systems in use and information is difficult to extract and correlate.

8.6 SECURITY

Transport Canada is responsible for ensuring the security and safety of airports and the travelling public. This is done through the deployment of security staff and the use of special equipment to ensure that no unchecked persons board aircraft, gain access to security areas or the airside of airports. The security equipment used is developed, specified, procured and maintained by Transport Canada personnel. In the case of the travelling public, security check points are situated where passengers and luggage can be screened by electronic means prior to boarding aircraft.

8.7 THE NEW APPROACH

8.7.1 MAINTENANCE

Maintenance is changing from being based on a preventive maintenance approach with on-site repair to a concept based on checks of operational performance with on-site replacement of failed units. The new concept is described in the 'Maintenance 2000' concept paper produced by the Facilities Engineering and Systems Development Branch. The concept relies on the application of modern technology to enable the procedures and methods of maintenance to be changed. The stability and predictable behaviour of solid-state equipment will significantly reduce the maintenance workload. Additionally, the stability and predictable behaviour of solid-state equipment will enable maintenance procedures to be changed, from being based on regularly scheduled checks and adjustments, to being carried out only when the performance of the equipment degrades to predetermined limits. The monitoring of equipment performance will be implemented through the application of computer technology. Computer technology will be used to extend remote control, monitoring and diagnostic appraisal of performance to most facilities in the Canadian Airspace System. The use of such Control and Performance Monitoring systems (CPMS), in the future, will provide for the automatic monitoring and diagnosis of equipment from a central location. As a result, the need for maintenance travel will be further reduced and maintenance personnel will be consolidated into central locations.

To further reduce the need for site visits, emphasis must be placed on reducing the need for site and building maintenance and, where possible, arranging for any such maintenance to be done locally. Inherently more reliable sources of power, will be used. Diesel generators and other systems, that require frequent maintenance, will be replaced, where possible. These measures will further reduce the need for site visits and assist in consolidation of the workforce.

The full conversion to reliable solid-state equipment, revised maintenance policies and maintenance monitoring from central locations will significantly reduce operating costs, without incurring any degradation in service.

At the present time a project office is being established to be responsible for the specification, procurement and installation of CPMS. A related project to provide workstations for the Electronics Duty Manager in Area Control Centres (ACCs) is in the initial procurement stage. These workstations will provide performance information relating to communications, navigational and surveillance systems within the ACCs.

8.7.2 FLIGHT INSPECTION

The introduction of the new aircraft and the DFIS and SCAPE will be complete by 1986. The overall benefit, including the reduction in the number of bases, will be lower costs and significant savings in fuel. In the near term, DFIS and SCAPE will be enhanced to include a flight evaluation capability for MLS, communications, and radar systems and the detection of electro-magnetic interference.

8.7.3 TECHNICAL TRAINING

Computer Assisted Learning (CAL) techniques will be introduced as a means of enhancing the training of technical personnel. For example, CAL techniques will be used to keep maintenance staff up-to-date as the reliability of modern systems will reduce their exposure to a variety of maintenance situations. The introduction of CAL will effect savings by reducing the need for travel and time away from the job. To minimize costs CAL packages will be specified and procured, as appropriate, as part of the contract in equipment procurement.

8.7.4 TECHNICAL SUPPORT

The need to provide engineering support, configuration management and to develop new procedures to accommodate the growth in systems will require more space than currently exists in the Technical Systems Centre. The needs of new projects, such as the Radar Modernization Program (RAMP) and the Microwave Landing System Program (MLSP), requires expansion of the existing technical support facilities.

The implementation of new maintenance procedures, based on performance monitoring, further emphasizes the need for accurate and up-to-date historical and day-to-day operational information. By incorporating data bases in the Control and Performance Monitoring System (CPMS) trend analysis can be used to predict system failures and other information can be gathered that will be used to improve system design as well as maintenance procedures and methods.

8.7.5 SECURITY

Significant improvements will be made to all aspects of the present Canadian Airport Security System (CASS). These will include the use of pattern recognition in the X-Ray System, automatic monitoring of the metal detectors and new types of explosive detectors.

8.8 QUALITY ASSURANCE

Quality Assurance will be an integral part of the life cycle management of all CASP facilities, equipments and systems.

Quality Assurance will be implemented as a closed loop system during the following three phases.

8.8.1 ASSURANCE ENGINEERING

This function is primarily concerned with the planning, design, development and testing phases of CASP projects. At the planning stage assurance engineers translate operational requirements into technical performance requirements for availability, reliability, maintainability and testability for inclusion in technical specifications and requests for proposals. Contractors proposals are evaluated based on these performance requirements and successful contractors are required to develop and maintain formal programs in these areas for both hardware and software. Predictions and apportionments of Availability, Mission Reliability, Maintenance Intervals, System Integrity, Continuity of Service, etc. will be required along with full and detailed Failure Mode Effects and Criticality Analyses. Verification and Design Approval Tests, both in plant and in the field, will be used to validate design predictions and analyses.

8.8.2 PRODUCT ASSURANCE

This function will be carried out during the manufacturing and production phase. Successful contractors will be required to develop and maintain a quality system commensurate with the appropriate contract. This may consist of a manufacturing inspection program (as a minimum) or a full Quality Assurance program. Type sample testing will be required to assure that production equipments/systems meet performance and quality requirements. Product Assurance maintains surveillance of contractors to ensure contractual terms and conditions are satisfied. Feedback to assurance engineers of deficiencies observed during manufacturing inspection and tests are an important part of the closed loop system.

8.8.3 SERVICE ASSURANCE

This function will be carried out during field installation and ongoing operational use and maintenance by audits, inspections and review of serviceability records. Feedback to assurance engineers will ensure reliability/availability growth and by the use of this information in the replacement planning phase will ensure the non re-occurence of similar design deficiencies in future systems and equipments. This is an important function in closing the Assurance loop.

8.9 EVOLUTION OF THE SYSTEM

CURRENT PROGRESS (TO 1985)

Current activities described in the previous paragraphs are in transition and their completion will occur in the near (to 1990) or long (to 2000) term.

8.9 EVOLUTION OF THE SYSTEM Cont'd

NEAR TERM (TO 1990)

The introduction of CPMS, together with improvements to the reliability and availability of power systems, will allow the consolidation of the maintenance workforce and the establishment of consolidated maintenance centres.

The data bases in the CPMS will provide improved inventory control and assessment of system performance in the field for equipment maintenance purposes.

Installation of Electronics Duty Manager Workstations (EDMWS) will provide centralised performance monitoring of all systems located in the ACCs.

New procedures and methods for flight inspection of present navigational aids will be fully implemented. Development of operational performance and assessment functions for MLS, radar, communications and surveillance facilities and evaluation of electromagnetic interference and methods to improve calibration of aircraft antenna systems will be undertaken. The number of flight inspection aircraft will be reduced to four and the number of bases to two.

The need to provide a means of enhancing the training of operational personnel will see the introduction of Computer Assisted Learning methods.

The technical support of the many new systems will require expansion of the Technical Systems Centre.

Implementation will start on new explosive detectors. Pattern recognition will be applied to new X-Ray systems to improve screening performance. Developments on automated passenger screening and passenger/checked baggage matching will commence.

LONG TERM (TO 2000)

Most field maintenance personnel will be located at centrally manned stations. The CPMS will be used to monitor, test and control facilities at remote sites and monitor the long term performance of the Canadian Airspace System. The application of trend analysis will be used to update procedures and methods to ensure that maintenance is carried out in the most efficient and effective manner. Data from flight inspections will be fed into the CPMS to enhance the basis for trend analysis of system performance.

The new automated passenger screening and passenger/checked baggage match systems will be implemented.

8.10 BENEFITS OF THE PLAN

Improved procedures and methods of operating the maintenance and support systems will result in a more efficient use of available resources, a consolidation of operations and a reduction in the need for staff.

The widespread utilization of highly reliable solid-state equipment, together with modern computer and communications technology will enable significant savings to be made in O & M costs to the year 2000.

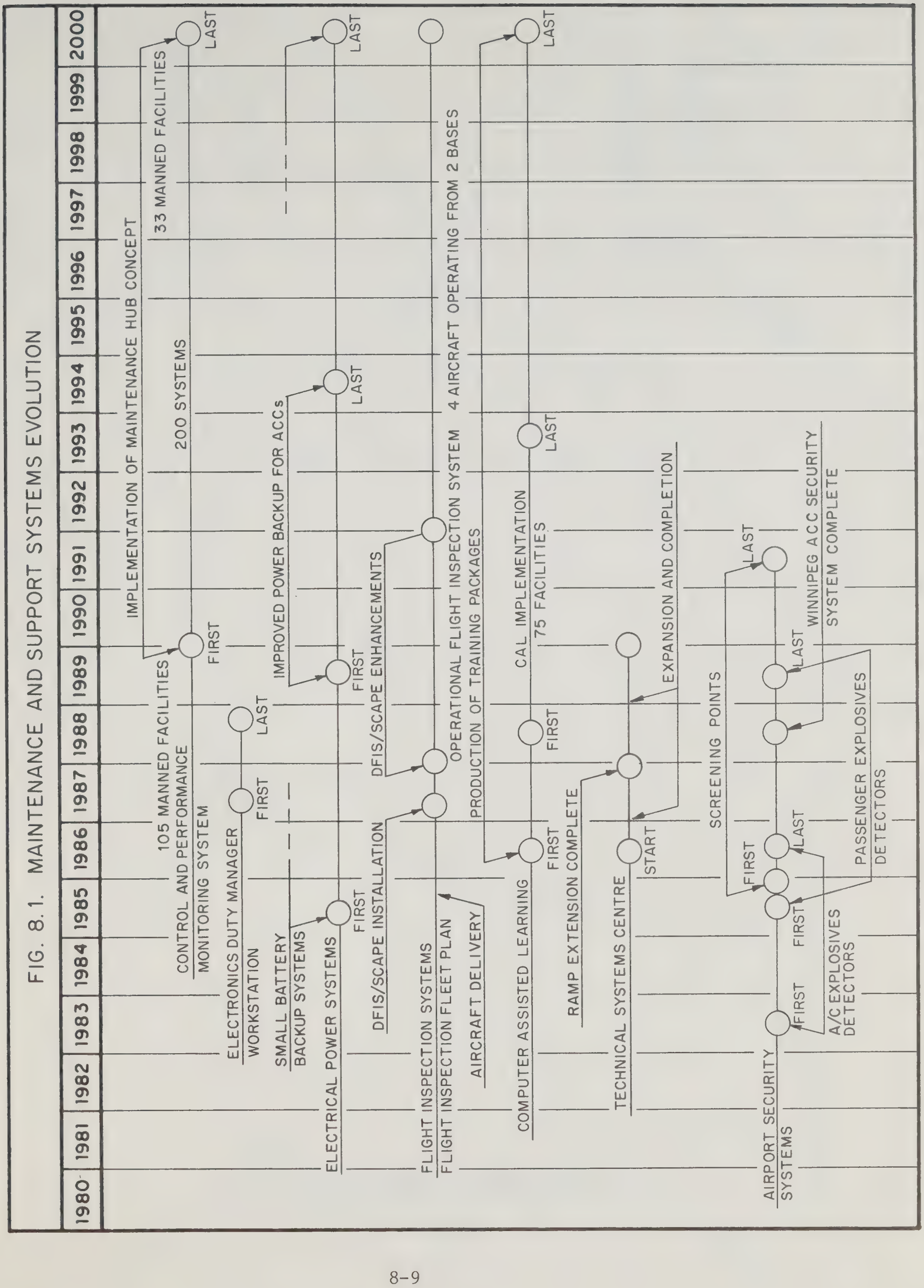


FIG. 8.1. MAINTENANCE AND SUPPORT SYSTEMS EVOLUTION

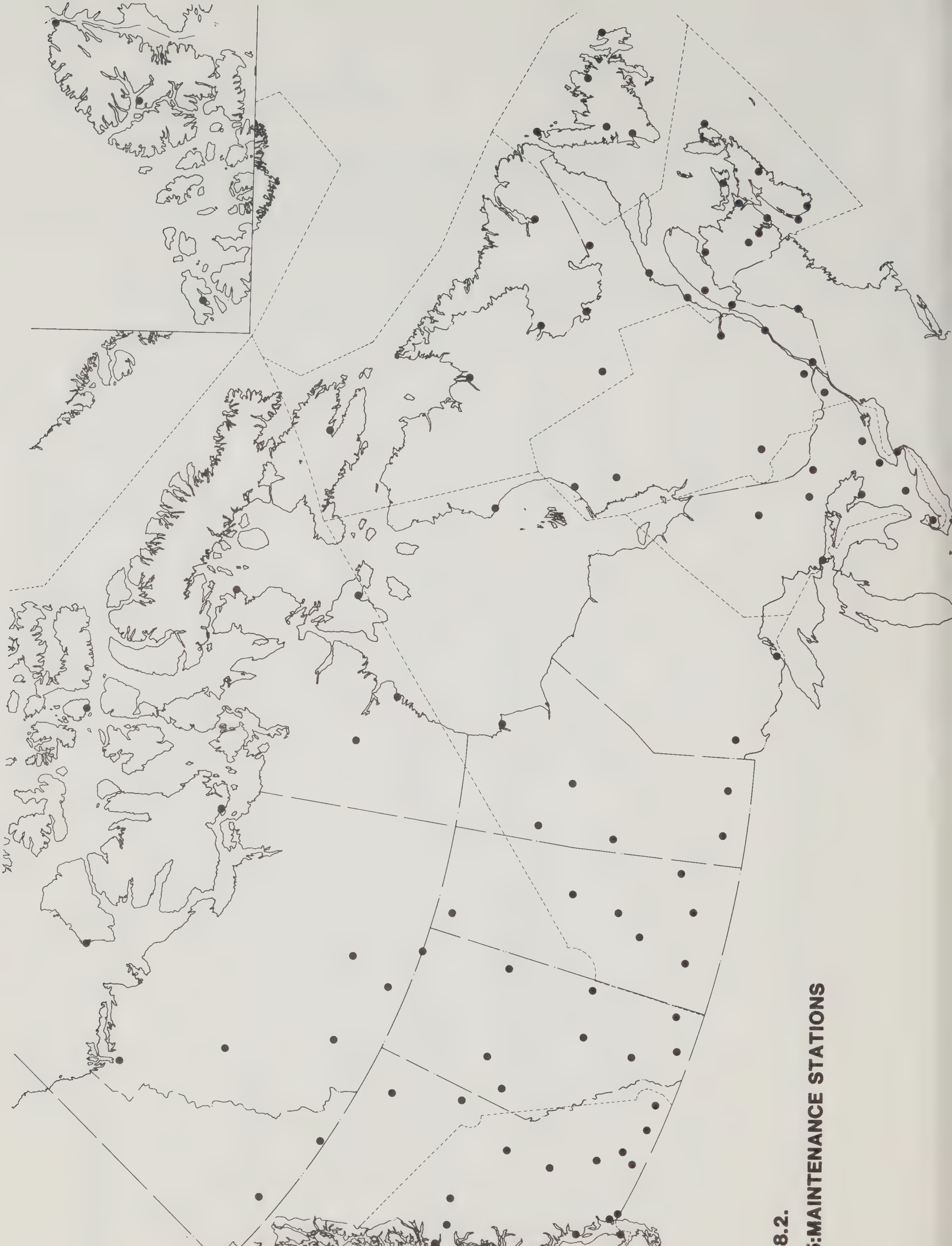


FIG. 8.2.
1985:MAINTENANCE STATIONS

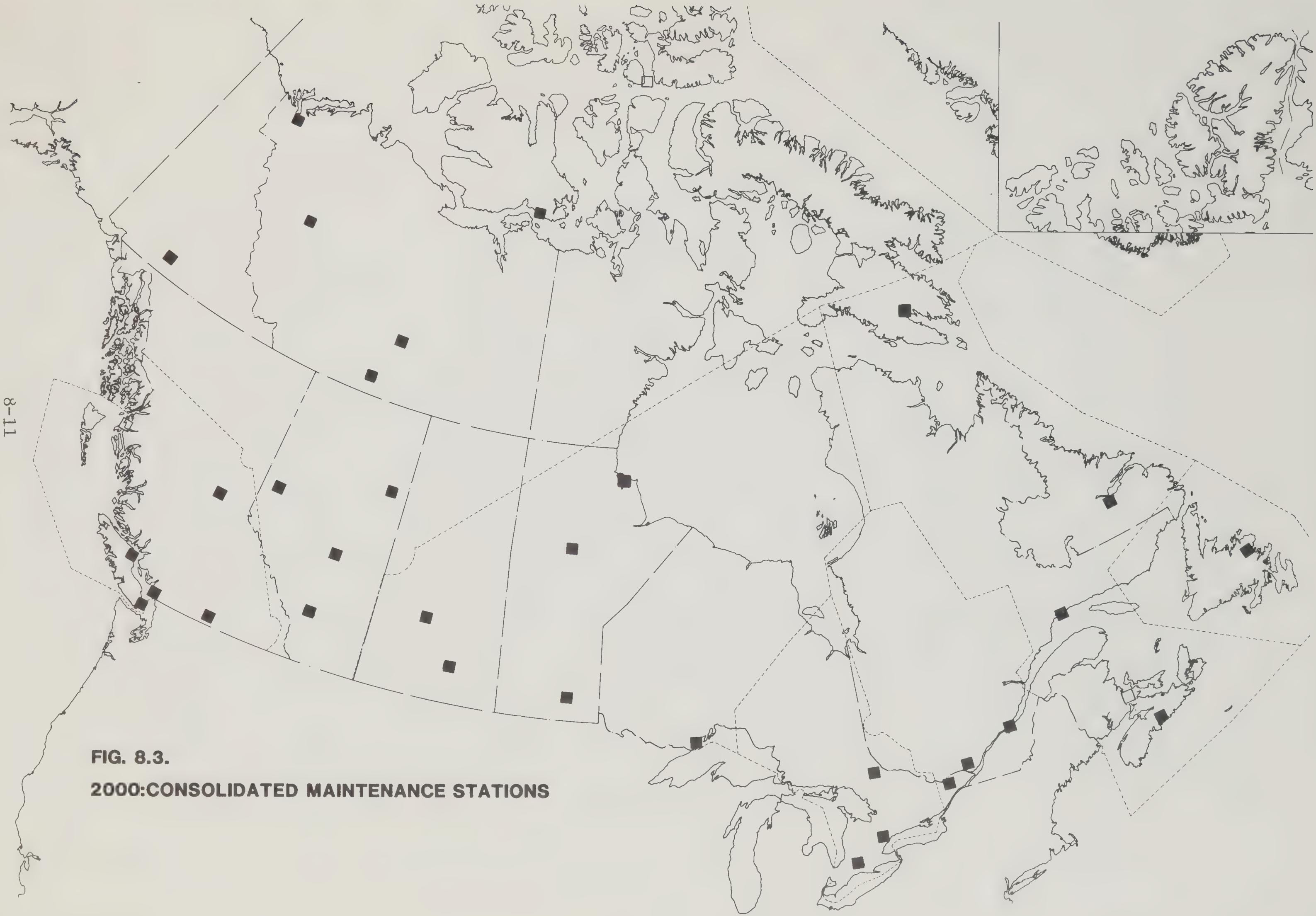


FIG. 8.3.

2000:CONSOLIDATED MAINTENANCE STATIONS

	PROJECT	IMPLEMENTATION 1st	IMPLEMENTATION Last
	MAINTENANCE		
1.	Control and Performance Monitoring System (CPMS)	1990	2000
2.	Electronics Duty Manager Workstation (EDMWS)	1987	1988
3.	Electrical Power Systems (Primary & Standby)	1985	2000
	FLIGHT INSPECTION		
4.	The Flight Inspection Fleet Plan	1984	1987
	TRAINING		
	(See Chapter 9)		
	TECHNICAL SUPPORT		
5.	Technical Systems Centre	-	1989
	SECURITY		
6.	Airport Security Systems	1985	1991

PROJECT: 1. CONTROL AND PERFORMANCE MONITORING SYSTEM (CPMS)

PURPOSE: To provide a system capable of monitoring and controlling remote equipment, from a central location. Additionally, maintenance information and performance statistics necessary for life-cycle management purposes will be collected and processed by the CPMS. The system will reduce staffing requirements, improve work force efficiency, reduce the amount of on-site test equipment and spare parts and be instrumental in bringing about consolidation of the maintenance personnel into centrally manned stations. The long-range goal is to develop, a standard CPMS that can be universally used.

APPROACH: The CPMS will consist of a telemetry/controller at the remote end linked through local network facilities to interface units on the equipment to be monitored/controlled. The telemetry/controller will be linked through the interfacility network to a monitoring position in the central maintenance station.

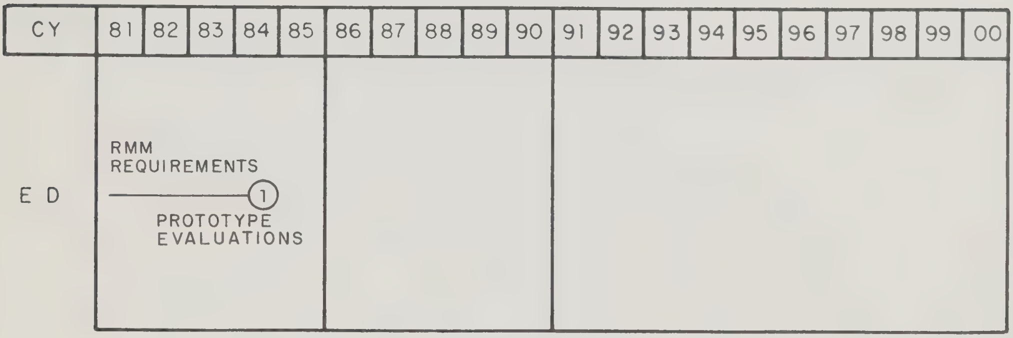
QUANTITIES: Approximately 2000 maintenance sites will be remoted back to central maintenance locations. The first system will be installed in 1990.

RELATED PROJECTS/ACTIVITIES:

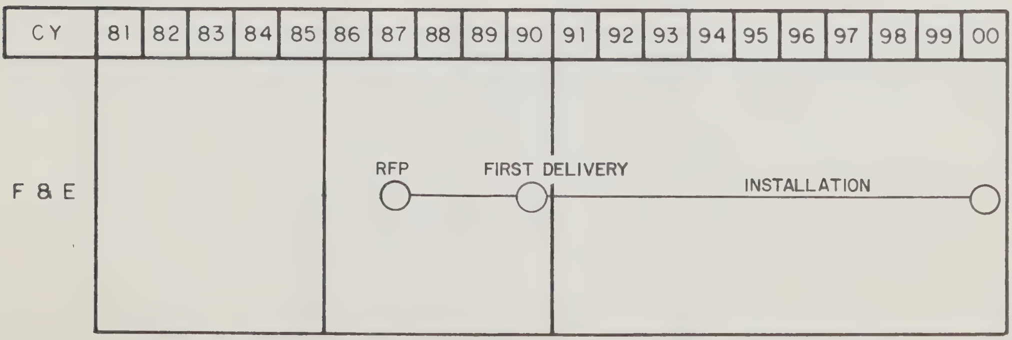
- Consolidation of manned maintenance stations.

CONTROL & PERFORMANCE MONITORING SYSTEM

SCHEDULE



SCHEDULE



PROJECT: 2. ELECTRONICS DUTY MANAGER WORKSTATION (EDMWS)

PURPOSE: To provide a system capable of monitoring all systems in the area control centre from a single position. Configuration, operational status and failure warning information will be displayed. The system will allow minimal maintenance staff support during quiet hours.

APPROACH: The EDMWS will connect to the ACC systems and receive regular status reports. Information will be displayed in tabular and graphic presentations under control of a menu driven operator interface. Direct connection to and display of data inputs to the ACC will also be possible.

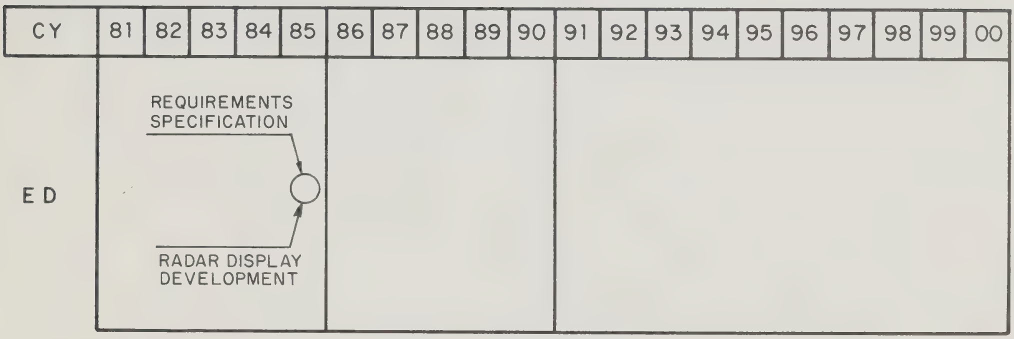
QUANTITIES: EDMWS systems will be installed at all area control centres and the Technical Systems Center.

RELATED PROJECTS/ACTIVITIES:

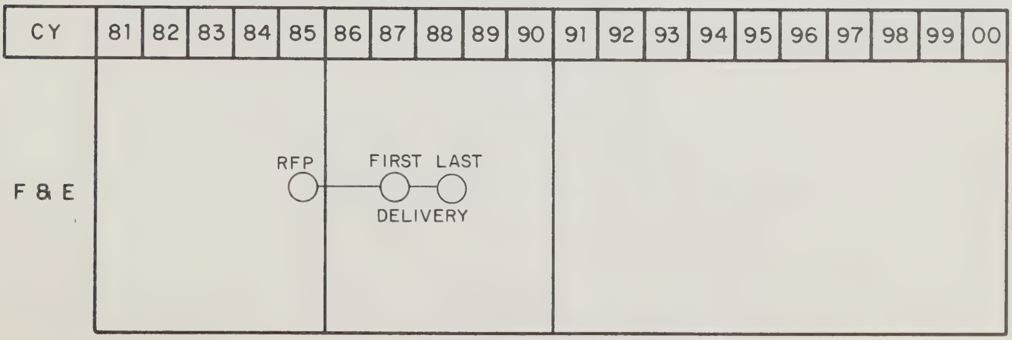
- CPMS

ELECTRONICS DUTY MANAGER WORK STATION (EDMWS)

SCHEDULE



SCHEDULE



PROJECT: 3. ELECTRICAL POWER SYSTEMS (PRIMARY AND STANDBY)

PURPOSE: To improve the reliability and availability of electrical power systems. In view of the high reliability of the other equipment, electrical power is now a weak link in the performance of many systems. The reliability and availability of electrical power must be improved and the need for maintenance of the electrical power systems reduced, prior to consolidation of the maintenance workforce. An availability study has shown that loss of power to equipment contributes to 90% of system outages.

APPROACH: Large back-up power requirements, such as in Area Control Centres (ACCs), are currently backed up by complex emergency power units, which are maintenance intensive and prone to failure. An investigation of such power systems will be undertaken to reduce complexity and improve reliability and availability. Small back-up power requirements can be readily made more reliable by the installation of Static Uninterruptible Power Units (SUPUs) which provide a battery based DC power supply in the event of power failure.

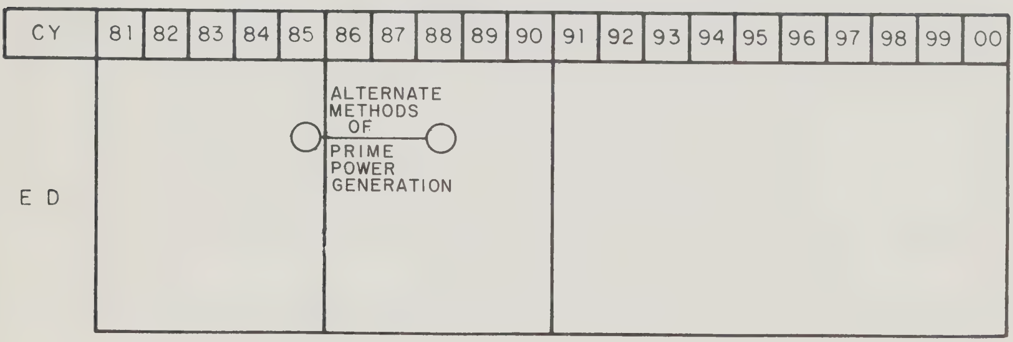
QUANTITIES: At the present time, 100 SUPUs are being procured to support Air/Ground communications equipment. These will be installed by 1989. 33 large SUPUs will be procured, with installation to start in 1988 and be completed in 1992.

RELATED PROJECTS/ACTIVITIES:

- None.

ELECTRICAL POWER SYSTEMS (PRIMARY & STANDBY)

SCHEDULE



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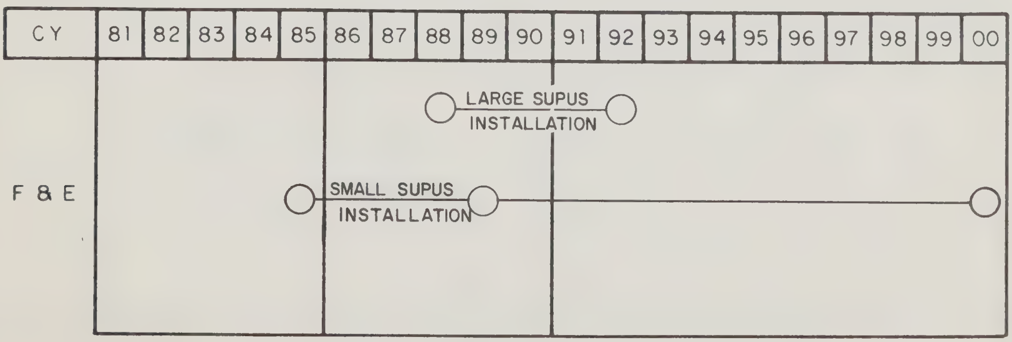


PROJECT: 4. THE FLIGHT INSPECTION FLEET PLAN

PURPOSE: To acquire modern fuel efficient aircraft and consolidate flight inspection bases.

APPROACH: Beyond 1985, the introduction of DFIS/SCAPE into the new flight inspection aircraft will enable a reduction in the number of aircraft and bases. Two different types of aircraft will be used. Jet aircraft, operating efficiently at higher altitudes and speeds, will enable the more distant and spread-out facilities to be inspected in less time and in fewer flights. The use of turbo-prop aircraft will be more efficient in low altitude work and provide more flexibility in inspecting certain facilities. Concurrent with these changes a restructuring of the operational flight inspection organization and methods of operation will be undertaken.

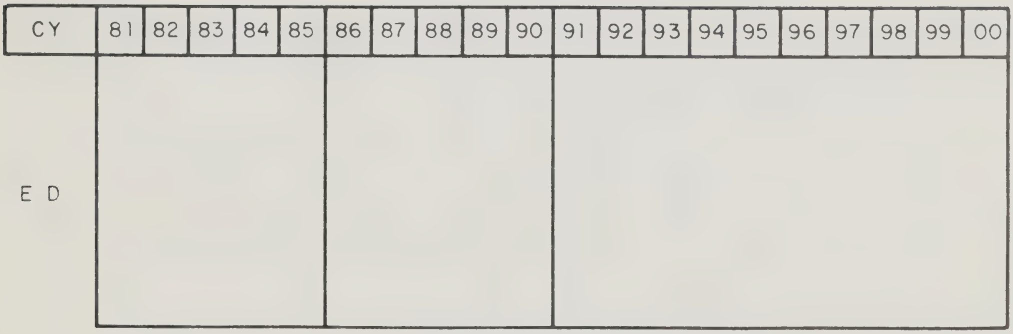
QUANTITIES: Two high speed and two medium speed aircraft. One of each type of aircraft to be based at each of two bases; one base in Eastern and the other in Western Canada.

RELATED PROJECTS/ACTIVITIES:

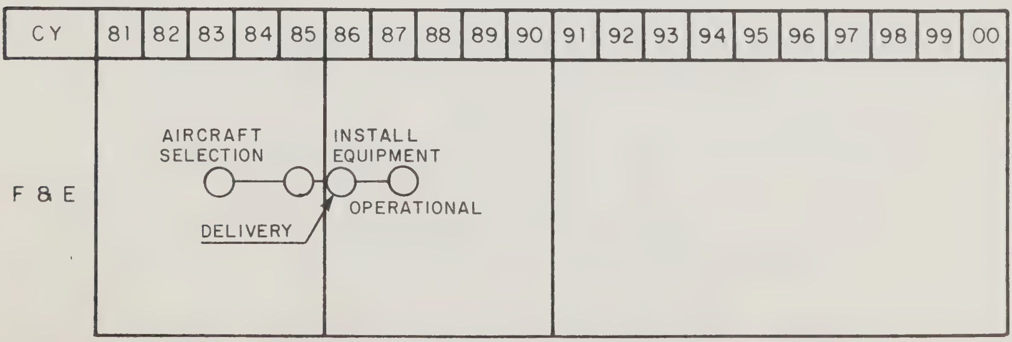
- Flight Inspection System Development

THE FLIGHT INSPECTION FLEET PLAN

SCHEDULE



SCHEDULE



PROJECT: 5. TECHNICAL SYSTEMS CENTRE (TSC)

PURPOSE: To establish a Technical Systems Centre to provide the necessary space for laboratories, engineering offices, test-bed systems and maintenance support facilities to accommodate the change in the technical support needs of the Canadian Airspace System brought about by technological development.

APPROACH: The need to provide engineering and maintenance support, configuration management and to develop new procedures to accommodate the increasing complexity of systems will require more space than currently exists. At the present time a combined total of 5500 square meters of laboratory, test-bed and engineering office space is available. Growth predictions have established a requirement for 10000 square meters. Expansion is necessary to:

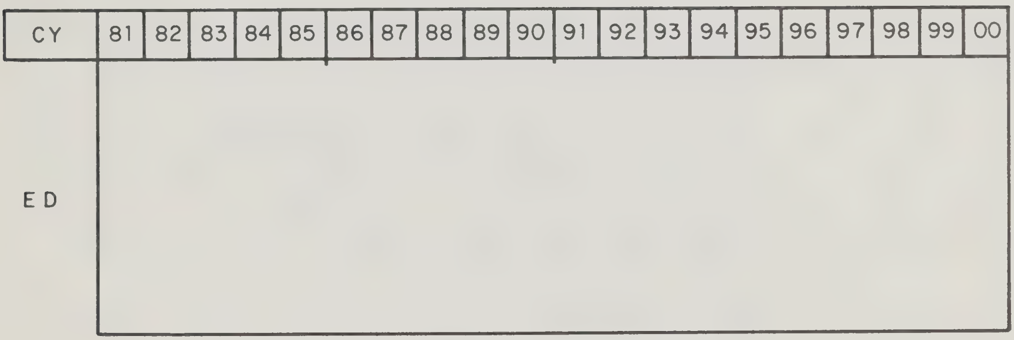
- ensure future laboratory, test-bed system, maintenance support facility and engineering office space requirements are met.
- enable common services and equipment to be shared and used more effectively.

QUANTITIES: An extension to the present facilities to accommodate RAMP will be completed by mid 1987. The second extension and the renovations to the existing building are scheduled for completion by 1990.

RELATED PROJECTS/ACTIVITIES:

TECHNICAL SYSTEMS CENTRE (TSC)

SCHEDULE



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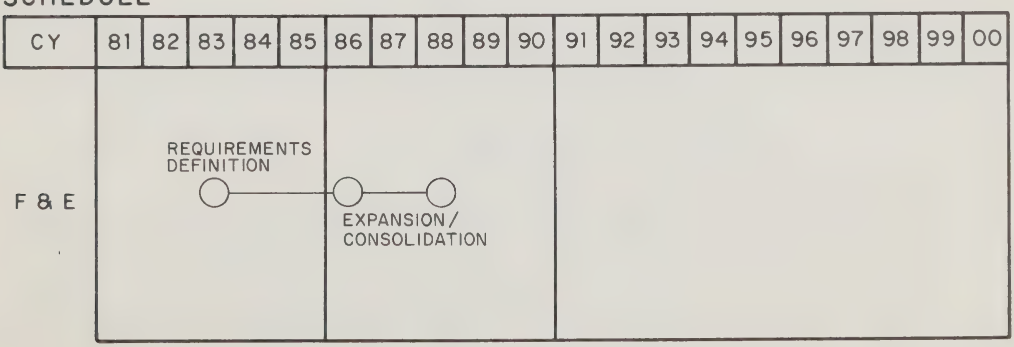


PROJECT: 6. AIRPORT SECURITY SYSTEMS

PURPOSE: To minimize costs associated with airport security and improve security systems now in place. Security measures are necessary to comply with government legislation requiring security at airports to protect passengers, crews and aircraft.

APPROACH: The approach is being carried out in six parts as follows:

- Canadian Airport Security Systems (CASS) - Card access equipment, closed circuit television and the provision of alarms on doors is currently being implemented to enhance security at 13 airports. This equipment will provide labour and dollar savings by reducing guard requirements (62 person years) and improve the efficiency and effectiveness of police and guard resources. A further expansion of access control systems at these and other airports will be implemented.

- Pattern Recognition X-Ray Systems - This part of the project will incorporate an alarm in the luggage X-Ray equipment to attract the operator's attention to suspect luggage. It has been found that operators have difficulty in maintaining attention during a duty shift when viewing the luggage X-Ray monitor for long periods of time.

- Performance Monitoring of Present X-Ray/Walk-Through Screening Points - Sensors will be fitted within the walk-through area to monitor that the electromagnetic field is within the prescribed performance limits. In the event that the limits are exceeded an alarm will be given. This will increase performance reliability and safety while providing technician and/or operator resource savings. Enhancements to the X-Ray system will also be implemented.

- Explosives Detection - Explosives detection equipment is being procured for use at airports, to screen aircraft and as an aid in bomb searches. Validation and operational testing will be carried out together with the determination of procedures for use in the checked baggage make-up areas, in checking baggage containers and in the screening of buildings and baggage lockers. Work will continue to enhance the operation of current explosive vapour detectors as well as to develop a real-time detector for use in conjunction with X-Ray units and walk-through detectors.

- Baggage/Passenger Match - This part will consist of two phases.

  (a) Phase 1 will develop a data base and the system necessary to match passengers with checked baggage.
  (b) Phase 2 will provide information on the location of passengers and baggage throughout the boarding process. In the event of an alarm the system will assist in the location of passengers and baggage.

PROJECT: 6. AIRPORT SECURITY SYSTEMS Cont'd

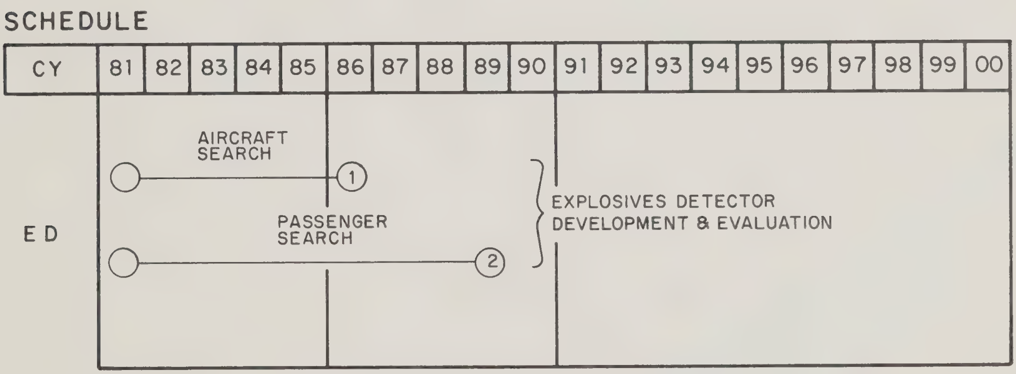
- Air Traffic Control Systems Security - A security system for Winnipeg ACC is currently under project implementation. The system will permit ACC access to authorized personnel only. This project will be extended to other ACCs, and other ATS facilities, as the requirement arises.

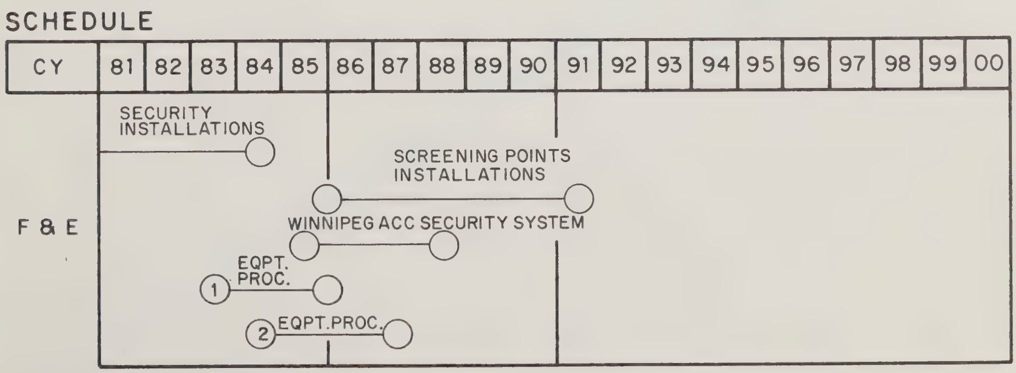
QUANTITIES:

Airport Security Installations	13 Airports	Complete by 1985
Automatic Alarm for X-Ray Systems	60 Screening Points	Complete by 1988
Automated Passenger Screening Points	60 Screening Points	Complete by 1991
Explosives Detectors	23 Aircraft Search Equipments	Complete by 1986
	60 Passenger Search Equipments	Complete by 1989

RELATED PROJECTS/ACTIVITIES:
- None.

AIRPORT SECURITY SYSTEMS





CHAPTER 9

ENGINEERING DEVELOPMENT

CHAPTER 9 ENGINEERING DEVELOPMENT

Contents

CHAPTER 9 ENGINEERING DEVELOPMENT

9.1 GENERAL

The Canadian Airspace Systems Plan (CASP) outlines the projects and strategy to meet the requirements of the air navigation system for the year 2000. Major projects such as the Flight Data Systems Modernization Project (FDMP), and the Flight Information Services Automation (FISA) will be implemented within the next five years. Existing systems will be upgraded to meet new and changing requirements and improve safety. Most of these CASP projects will require a support activity in advance of major resource commitments.

Engineering development provides the preliminary effort toward both the implementation of new systems and the enhancement for installed systems. It encompasses the total activity from the defintion of operational and technical requirements, through the development of a prototype, to the preparation of an implementation specification, and it identifies the benefits, the costs and the feasibility of available alternatives.

The engineering development activity outlined in this chapter highlights those efforts required to support the projects in the other sections of the Canadian Airspace Systems Plan and it provides a summary of any development identified in those sections. In some cases, where technology is still fairly new, as in navigation satellites, engineering development may be the only activity identified. Overall, this development provides a definition and direction to the CASP implementation.

A main objective of this effort is to provide coordination of all CASP related development activities within the Transport Canada Aviation Group, and with similar endeavours in other project offices, nationally and internationally. This coordination will result in a directed program, reducing duplication of effort and ensuring the best use of scarce resources. It will assist the two-way dialogue in the development of international aviation standards by providing data to support Canadian interests in their preparation and helping to adopt those standards with minimal impact. The CASP engineering development plan itself will undergo continual review and modification to reflect new and changing requirements of the aviation community.

It must be emphasized however, that engineering development, as defined here, differs from pure Research and Development (R&D). The former, in keeping with the philosophy of the Canadian Airspace Systems Plan, applies proven technology to meet operational requirements. It implies low risk development, whereas pure R&D investigates new technology and is therefore, by nature, higher risk. R&D does not form part of the CASP engineering development strategy, but it is related to the CASP and may be undertaken and supported by other organizations and other activities and projects. As such, some areas of R&D that could provide technology support to CASP in the future have been included in this chapter.

9.1 GENERAL Cont'd

The projects described in this chapter relate to the Communication, Navigation and Surveillance (CNS) systems, the associated information processing systems, the security systems, and the maintenance systems outlined in the preceeding chapters. Some advanced investigations are included to prepare for the use of technologies, such as artificial intelligence and voice recognition, that are still undergoing research, but which are expected to be fully mature before the CASP is completely implemented. Some projects previously underway, will continue to be persued and will yield considerable benefit. The main thrust of all these projects is to improve the utilization of available resources and to enhance the reliability, maintainability and safety of the total air navigation system.

9.2 PROGRAM OF PROJECTS

1. Advanced Air/Ground Communications and Data Link Studies

2. Speech Processing and Transmission Systems Development

   - digital signal processing and storage
   - Automated Transcribed Weather Broadcast
   - voice generation and recognition

3. Telecommunications Network Investigations

4. Navigation Satellite System Support Development

   - quality evaluation systems
   - differential
   - pseudolites
   - simulator
   - integrity enhancement system
   - GEOSTAR evaluation

5. LORAN-C Coverage Studies

6. VLF/Navigation Transmitter Evaluations

7. Microwave Landing System Support Development

   - antenna testing
   - site simulation and evaluation
   - equipment type approval
   - Instrument Landing System collocation
   - frangibility studies

8. Airport Surface Navigation Development

9. Automatic Dependent Surveillance Investigations

10. Surveillance Systems Enhancements

    - Airport Surface Detection Equipment target identification
    - Secondary Surveillance Radar Mode S upgrade
    - Programmable Geographic Attenuator
    - Radar Data Reformatter

9.2 PROGRAM OF PROJECTS

11. Development of Radar Support Facilities

    - coverage prediction
    - performance evaluation systems
    - transponder calibration

12. Weather Detection, Processing and Dissemination Systems

    - Automated Weather Observing and Reporting System
    - aviation weather processing
    - Low Level Wind Shear Detection Systems
    - weather radar
    - Runway Visual Range light source investigations

13. Low Level Wake Vortex Alert Investigations

14. Flight Data Processing Investigations

    - conflict alerting and hazardous airspace warning
    - conflict resolution advisory
    - flow management/metering and sequencing
    - aRea NAVigation (RNAV)
    - Northern Airspace Systems Design

15. Aeronautical Information Systems

16. Workstation Ergonomics Studies

    - Common Controller Workstation
    - Flight Service Specialist Workstation
    - Maintenance Workstation
    - Direct User Access Terminals
    - graphics standards

17. Consolidation of Air Navigation System Facilities

18. Flight Inspection System Development

    - Microwave Landing System
    - air/ground communication
    - surveillance systems
    - ElectroMagnetic Compatibility (EMC)
    - aircraft antenna calibration

9.2 PROGRAM OF PROJECTS

19. Remote Maintenance and Monitoring Development

20. Alternative Power Sources

21. Airport Security Systems Development

    - pattern recognition x-ray devices
    - explosives vapour detectors
    - Automated Passenger Screening Point
    - screening point enhancements

22. Artificial Intelligence/Expert Systems Investigations

23. Computer-Based Training Studies

PROJECT: 1. ADVANCED AIR/GROUND COMMUNICATION AND DATA LINK STUDIES

PURPOSE: Data transmission to and from aircraft is becoming increasingly important as more information is requested and made available. Pilots require inflight weather information and clearances, air traffic controllers and flight service specialists request flight plan and position information, and air carriers use similar information to schedule services and facilities. Air/ground communications are also being provided for passenger convenience. Existing voice communication systems are limited in providing the data capacities needed and northern and oceanic areas require alternative technologies to be applied. Automatic Dependent Surveillance will necessitate the transfer of large amounts of data without operator or pilot involvement.

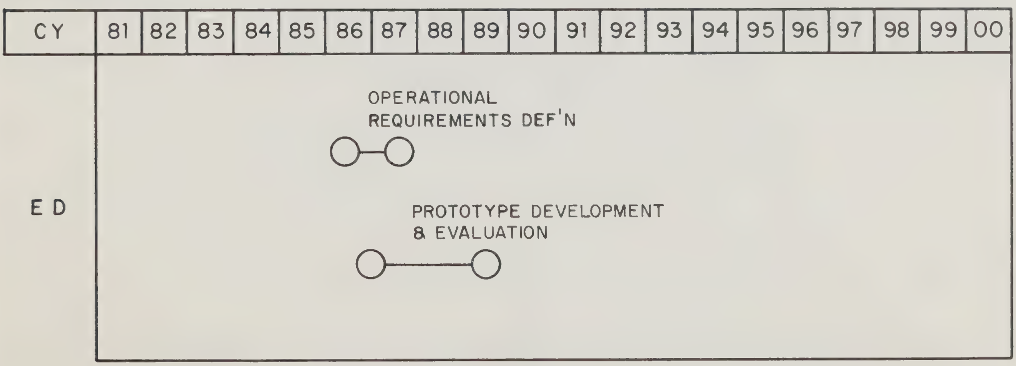
APPROACH: The project will focus primarily on the areas of HF and satellite systems to provide communication and data link facilities. Feasibility and requirement studies will determine the economies and efficiencies of alternative approaches. Prototype systems and sub-systems such as antennas and modems, will be developed and evaluated. Reports will be presented to national and international aviation communities. When the operational requirements are fully developed, the specifications for implementation systems can be prepared.

RELATED PROJECTS:

Flight Data Systems Modernization Project
Flight Information Services Automation
Automatic Dependent Surveillance Investigations
Surveillance Systems Enhancements
Workstation Ergonomics Studies
Weather Detection, Processing and Dissemination Studies
Low Level Wake Vortex Alert Investigations
Consolidation of Air Navigation System Facilities
Aeronautical Information Systems Studies
Microwave Landing System
Air Ground VHF Communications
Air Ground HF Communications
Canadian Aeronautical Digital Network

ADVANCED AIR/GROUND COMMUNICATION & DATA LINK STUDIES

SCHEDULE



PROJECT: 2. SPEECH PROCESSING AND TRANSMISSION SYSTEMS DEVELOPMENT

PURPOSE: The installation of air/ground data links and integrated communication control systems will require the replacement of analog voice circuitry by digital speech processors. Digital processing techniques will provide new capabilities and flexibility in air traffic control and flight service station communication systems. As well, a transition to a digital communication system will provide compatibility with national and international data networks and the capability to easily incorporate remote maintenance and monitoring techniques. System performance will be improved and maintenance requirements reduced.

APPROACH: A review of communications systems is being conducted on an ongoing basis and alternatives are examined for overcoming identified system limitations or deficiencies. Projects will be conducted in three main areas:

(a) Digital signal processing and storage techniques will be evaluated for application in the present communication systems, with a major objective of reducing life-cycle costs;

(b) The development of an Automated Transcribed Weather Broadcast (ATWB) system, using electronic speech synthesis techniques to replace present equipment, providing aviation weather information by telephone or on a selected broadcast frequency;

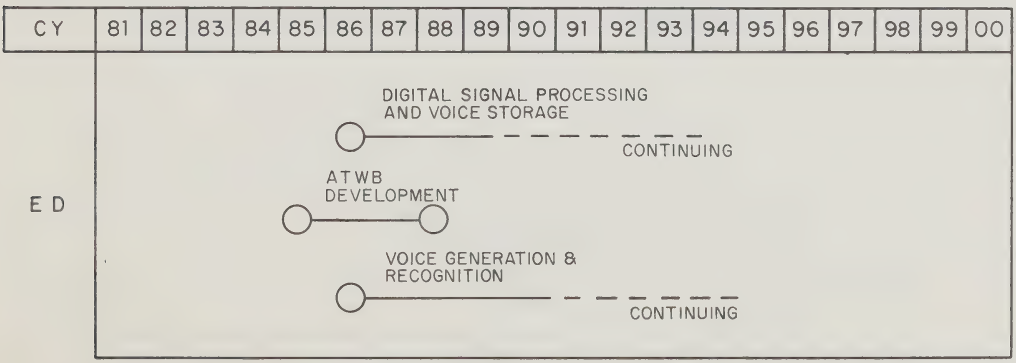
(c) Technology advances in voice generation and recognition will be closely monitored for potential as an interface device between people and the new automated systems.

RELATED PROJECTS:

Advanced Air/Ground Communication and Data Link Studies
Weather Detection, Processing and Dissemination Systems
Flight Information Services Automation
Aeronautical Information Processing System
Canadian Aeronautical Digital Network
Workstation Ergonomics Studies
Consolidation of Air Navigation System Facilities
Telecommunications Network Investigations
Aeronautical Information Systems Studies

SPEECH PROCESSING & TRANSMISSION SYSTEMS DEVELOPMENT

SCHEDULE



PROJECT: 3. TELECOMMUNICATIONS NETWORK INVESTIGATIONS

PURPOSE: The implementation of the new automated systems requires an interconnection scheme to accommodate the transfer of a large amount of data, quickly and efficiently. Local area networks will be used within facilities, and a single interfacility network will handle all data and voice communications between sites. Common networks will minimize the number of interfaces between systems. Preliminary investigations of the technical requirements for these networks will ensure maximum effectiveness and benefit is obtained when they are implemented.

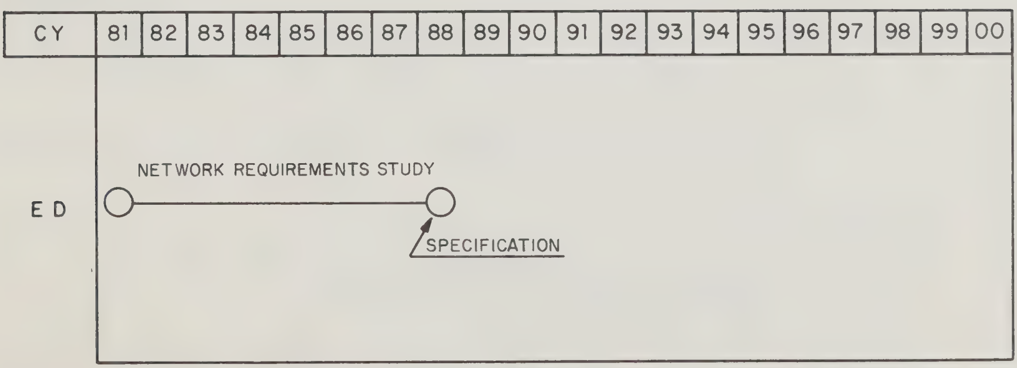
APPROACH: Virtually all systems included in the Canadian air navigation system will be interfaced to the common interfacility and intrafacility networks. Identification and standardization of these interfaces, both hardware and software, is a prerequisite to the network implementation. Studies will be conducted to determine the interfaces, the data rates and the types, quantities, origin and destination of data to be accommodated. From this information appropriate interconnect standards will be adopted and data switching and transmission requirements will be identified. The network systems designs and specifications will be prepared.

RELATED PROJECTS:

Canadian Aeronautical Digital Network
Advanced Air/Ground Communication and Data Link Studies
Radar Modernization Project
Flight Information Services Automation
Flight Data Systems Modernization Project
Aeronautical Information Processing System
Control and Performance Monitoring System
Automatic Dependent Surveillance Investigations
Workstation Ergonomics Studies
Aeronautical Information Systems Studies
Weather Detection, Processing and Dissemination Systems
Surveillance Systems Enhancements
Consolidation of Air Navigation System Facilities
Microwave Landing System

TELECOMMUNICATIONS NETWORK INVESTIGATIONS

SCHEDULE



PROJECT: 4. NAVIGATION SATELLITE SYSTEM SUPPORT DEVELOPMENT

PURPOSE: Satellite systems are being established by a number of countries, allowing three-dimension position information to be determined virtually anywhere on or above the surface of the earth with accuracies of within a few metres. For aviation users, these systems will eventually provide an international navigation system supporting direct, point-to-point flight. Claimed accuracies of the satellite systems supported with ground-based equipment would also allow them to supplement and eventually replace present landing systems. The savings and efficiencies in overcoming the limitations of ground-based navigation systems, such as siting and power availability, make future acceptance of navigation satellite systems inevitable. However, as an emerging technology, studies to determine operational procedures and requirements and the development and evaluation of support and monitoring systems are necessary.

APPROACH: A number of engineering development efforts are being undertaken internationally to adapt satellite-based navigation systems to the aviation support role. A number of these activities are required in Canada because of unique conditions such as climate, but all efforts will be coordinated internationally with other aviation agencies. Some general project areas are:

(a) Development of airborne and ground-based systems to evaluate the quality of signals from NAVSTAR throughout Canada;

(b) Investigation of both ground-based and airborne differential navigation, including various data linking schemes, to determine the applicability of NAVSTAR as a precision approach aid in Canada;

(c) Development and evaluation of pseudo-satellites or pseudolites (ground-based receivers/transmitters) to enhance precision without requiring a data link;

(d) Development of a simulator to determine the capabilities of avionics equipment for navigation satellite systems;

(e) Development of an integrity enhancement system to warn aviation users of NAVSTAR of an out-of-tolerance condition within ten seconds of its occurrence;

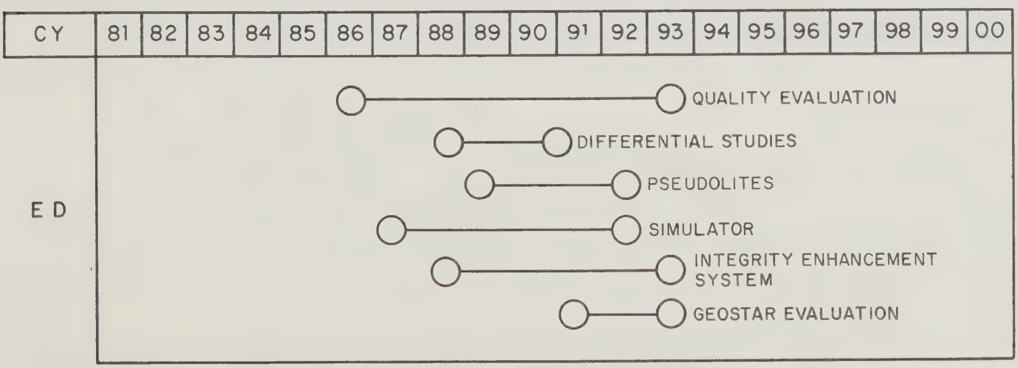
(f) Evaluation of GEOSTAR, a civilian, private navigation satellite system.

RELATED PROJECTS:

Automatic Dependent Surveillance Investigations
Airport Navigation System Development
LORAN-C Coverage Studies
VLF/Navigation Transmitter Evaluations

NAVIGATION SATELLITE SYSTEM SUPPORT DEVELOPMENT

SCHEDULE



PROJECT: 5. LORAN-C COVERAGE STUDIES

PURPOSE: LORAN-C is a low frequency navigation system developed primarily for marine use. Canada and the United States have constructed an extensive network of LORAN-C stations providing marine navigation along the coasts and in the Great Lakes region. The signals from these stations also provide useable coverage over a portion of the North American land mass. The coverage area, good accuracy and the advent of low-cost, microprocessor-based receivers has sparked a keen interest in the airborne use of LORAN-C. However, little is known of the actual extent of the coverage for airborne use and it requires further study.

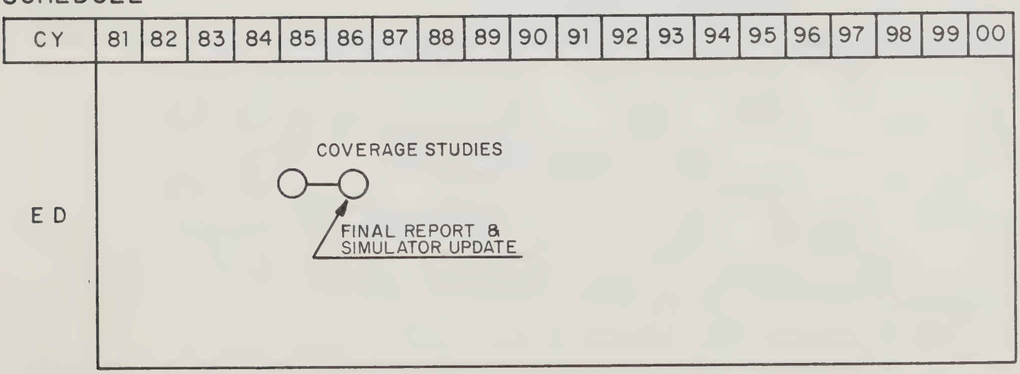
APPROACH: Coast-to-coast survey flights have taken place in Canada during recent winter and summer seasons. Data were collected through several different LORAN-C sensors and correlated geographically using an accurate independent means of position fixing. The same aircraft, airborne equipment and position fixing system was used for all FAA and Transport Canada flights to provide a homogeneous set of data. The data are processed using an existing analysis system and results are verified through cooperative, international data sharing agreements. Computer simulations are being conducted to augment these coverage measurements and recursively the results will be used to further validate Transport Canada's LORAN-C simulation study for auroral zone and earth topography effects. In addition to mapping the extent of LORAN-C coverage in Canada these efforts will also determine the number of new stations necessary to complete the coverage and the associated costs.

RELATED PROJECTS:

Automatic Dependent Surveillance Investigations
Navigation Satellite System Support Facilities
Airport Surface Navigation Development
VLF/Navigation Transmitter Evaluations
Development of Radar Support Facilities

LORAN C COVERAGE STUDIES

SCHEDULE



PROJECT: 6. VLF/NAVIGATION TRANSMITTER EVALUATIONS

PURPOSE: Although Omega is considered to provide world-wide coverage, there are certain areas of Canada (such as the "Winnipeg Hole") where coverage is inadequate. Traditionally, in these regions, the Omega coverage is supplemented by use of U.S. Navy VLF communications stations. The U.S. Navy has affirmed that although the VLF stations may be used for navigation, the stations may be withdrawn from service, frequencies changed or transmissions interrupted - all without notice.

In an effort to circumvent these problems, it has been proposed to install in Canada 2 VLF transmitter sites dedicated to Navigation.

Dedicated VLF stations could also be used to transmit GPS integrity data to GPS/OMEGA equipped aircraft operating in northern latitudes out of view of any geostationary satellites that may be transmitting integrity data.

APPROACH: To determine where these VLF transmitters should be located and the benefits to be derived from their use, a study contract was awarded to a consulting firm. The conclusion was that excellent system integrity could be achieved if one VLF transmitter station is installed at Cambridge Bay, Northwest Territories and one at Comfort Cove, Newfoundland. These findings were based on computer simulation.

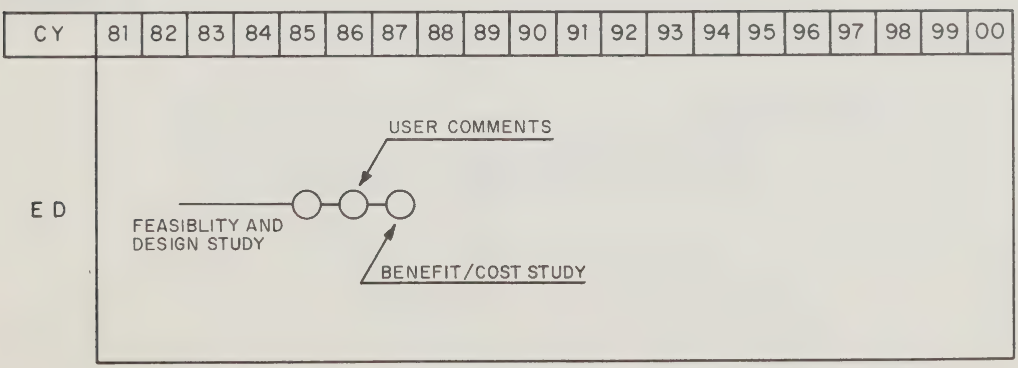
The next phase of the investigation should include benefit/cost studies, a survey of user requirements and actual field test measurements of the VLF signal characteristics including verification of the predicted coverages.

RELATED PROJECTS:

Automatic Dependent Surveillance Investigations
Navigation Satellite System Support Development
LORAN-C Coverage Studies
Development of Radar Support Facilities

VLF/NAVIGATION TRANSMITTER EVALUATIONS

SCHEDULE



PROJECT: 7. MICROWAVE LANDING SYSTEM SUPPORT DEVELOPMENT

PURPOSE: The Microwave Landing System (MLS) is still relatively new and there is little experience to draw from with respect to evaluation, installation and testing. A number of development initiatives are required to aid in performance prediction and measurement using various system and site parameters and options.

APPROACH: A series of projects will be undertaken prior to the installation of the MLS equipment:

(a) MLS Antenna Testing - New MLS measurement techniques will be developed in cooperation with agencies in other countries. Specifications will be prepared for a signal analyzer to carry out field measurements on a runway end to verify the accuracy of an installed system.

(b) MLS Site Simulations and Evaluations - Computer models will be obtained or developed to provide an assessment of the magnitude and location of MLS guidance errors and signal shadowing to be anticipated at various sites. This will also evaluate the effect of erecting new structures on or near the airport.

(c) Equipment Type Approval Program - A study will be performed to develop a technical standard for non-federal Microwave Landing Systems, to be included as part of Transport Canada's "Criteria for the Installation of Non-Federal Navigation Equipment".

(d) ILS Collocation - The effects of locating Instrument Landing System (ILS) and MLS equipment in close proximity will be investigated and measured. The results will determine options available for siting MLS equipment during the transition while ILS has to be sustained.

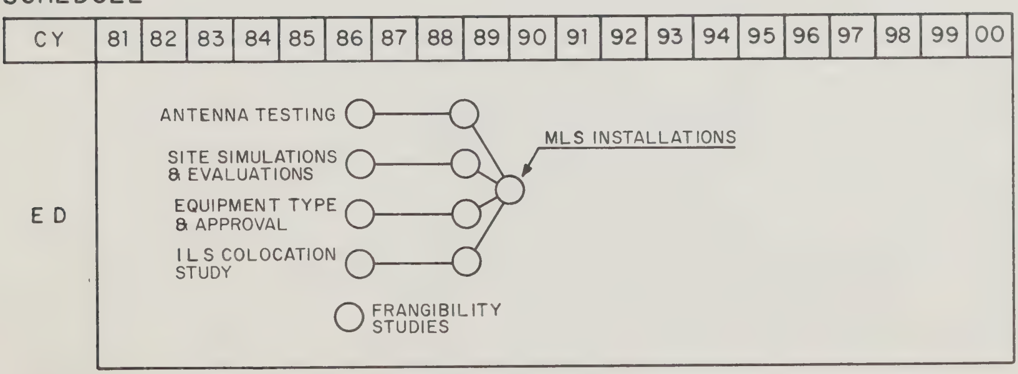
(e) Frangibility Studies - The specification requirements will be developed to provide an MLS shelter that can be located near runways without posing a hazard to aircraft.

RELATED PROJECTS:

Microwave Landing System
Development of Radar Support Facilities

MICROWAVE LANDING SYSTEM SUPPORT DEVELOPMENT

SCHEDULE



PROJECT: 8. AIRPORT SURFACE NAVIGATION DEVELOPMENT

PURPOSE: To fully exploit the benefits of Category III installations for landing under zero visibility conditions, it is necessary to be able to safely and independently deploy fire, rescue and snow removal vehicles, as well as provide aircraft navigation information, without visual reference to the ground. The development of an accurate surface navigation system will permit pilots and ground vehicle operators to manoeuver on the airport surface under such conditions. A number of navigation and surveillance systems presently installed or planned for installation in the near future, with some enhancements, may provide this capability.

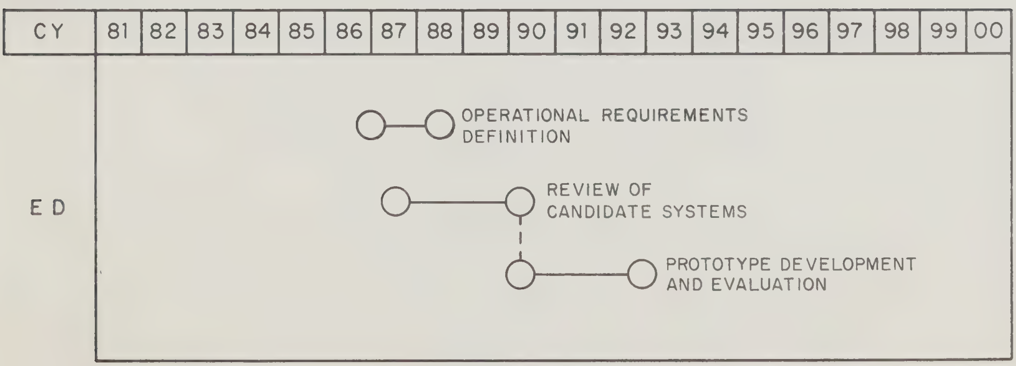
APPROACH: A review will be conducted of the operational requirements for a surface navigation system and the technical capability of various systems to meet them. Possible candidates are the Precision Distance Measuring Equipment (Microwave Landing System), Secondary Surveillance Radar, and navigation satellite systems. Prototype systems will be developed for evaluation and to test their feasibility. On-board equipment requirements will be considered as part of the system development. Specifications will be prepared to provide system enhancements in conformity with Category III precision approach facilities.

RELATED PROJECTS:

Microwave Landing System
Radar Modernization Project
Navigation Satellite System Support Facilities
Automatic Dependent Surveillance Investigations
Artificial Intelligence/Expert Systems Investigations
Advanced Air/Ground Communication and Data Link Studies
Airport Surface Detection Equipment

AIRPORT SURFACE NAVIGATION DEVELOPMENT

SCHEDULE



PROJECT: 9. AUTOMATIC DEPENDENT SURVEILLANCE INVESTIGATIONS

PURPOSE: International organizations are presently developing procedures and standards for Automatic Dependent Surveillance. This system uses three-dimensional position information obtained from navigation equipment on-board the aircraft and transmitted via a communications system or data link to a ground-based air traffic control facility for processing. Its greatest potential is in non-radar controlled airspace such as northern and oceanic areas.

Present international efforts are exploring the methodologies of choosing the appropriate navigation information for a number of available on-board systems, and the format for transmitting the information to the ground-based facility. Supporting studies are required for using the data received.

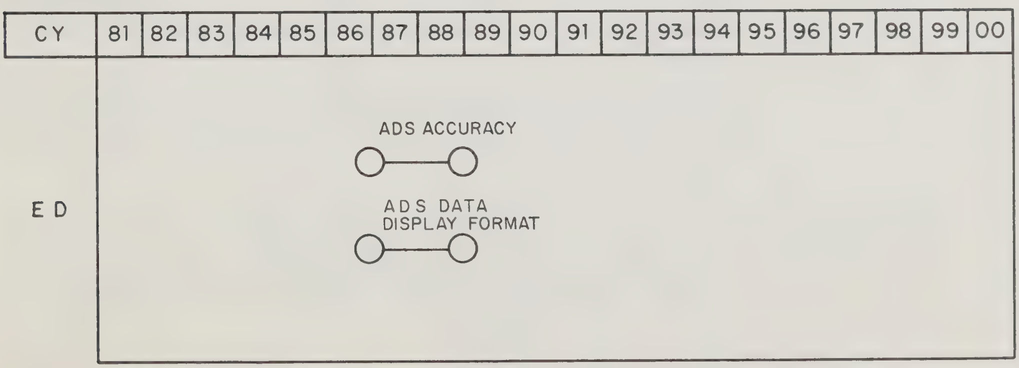
APPROACH: The operational requirements for Automatic Dependent Surveillance (ADS) will be confirmed and the accuracy of the data obtained from the on-board systems will be determined relative to the surveillance radar systems. Other efforts will study data link requirements, formats for displaying ADS data along with other air traffic control data, and aircraft tracking algorithms. Related studies are presently underway in cooperation with the Canadian aviation community. Information obtained from these development efforts will be coordinated internationally with other project offices conducting similar activities.

RELATED PROJECTS:

Flight Data Processing Investigations
Flight Data Systems Modernization Project
Navigation Satellite System Support Facilities
LORAN-C Coverage Studies
Workstation Ergonomics Studies
Advanced Air/Ground Communication and Data Link Studies
Telecommunications Network Investigations
Canadian Aeronautical Digital Network
VLF/Navigation Transmitter Evaluations
SSR Mode S Data Link
Air Ground HF Communications
Common Controller Workstation
Gander Automated Air Traffic System
Radar Modernization Project
Flight Information Services Automation

AUTOMATIC DEPENDENT SURVEILLANCE INVESTIGATIONS

SCHEDULE



PROJECT: 10. SURVEILLANCE SYSTEMS ENHANCEMENTS

PURPOSE: Increasing demands on the airspace system, coupled with new developments in technology, necessitate a continuing review of surveillance systems, their capabilities and limitations. Improvements are made where they are justified and can be incorporated in a cost-effective manner. They are based on operational requirements or technical deficiencies affecting life-cylce management, and they could be made nationally or on a site specific basis. The development activity determines the implementation alternatives and their relative benefits and costs.

APPROACH: An examination of the various surveillance systems has indicated possible areas where modifications or enhancements are necessary. Some have been identified to be of immediate concern:

(a) Airport Surface Detection Equipment (ASDE) Target Identification - Methods will be studied to provide identification tags to correlate targets on ASDE displays, such as service vehicles and landing, taxiing and departing aircraft. Different techniques will be examined and a prototype will be developed and evaluated. Results will be used in preparing a specification to retrofit all ASDE radars.

(b) Secondary Surveillance Radar (SSR) Mode S Upgrade - SSR Mode S provides both a data link capability to transfer air traffic control and meteorological data between aircraft and ground facilities, and a discrete interrogation capability to improve the detection and tracking performance of the surveillance system. The operational and technical requirements for Mode S will be examined and a prototype will be developed for the RAMP SSR system and evaluated. A specification will be written to upgrade those SSR systems.

(c) Programmable Geographic Attenuator (PGA) - The existing primary radars are unable to filter excessive clutter experienced at certain sites. The PGA is being developed and evaluated as an enhancement to present radars, to desensitize the receiver in discrete areas where clutter jeopardizes aircraft detection. Evaluation of a prototype will result in a specification to modify a number of the radars where the requirement is identified.

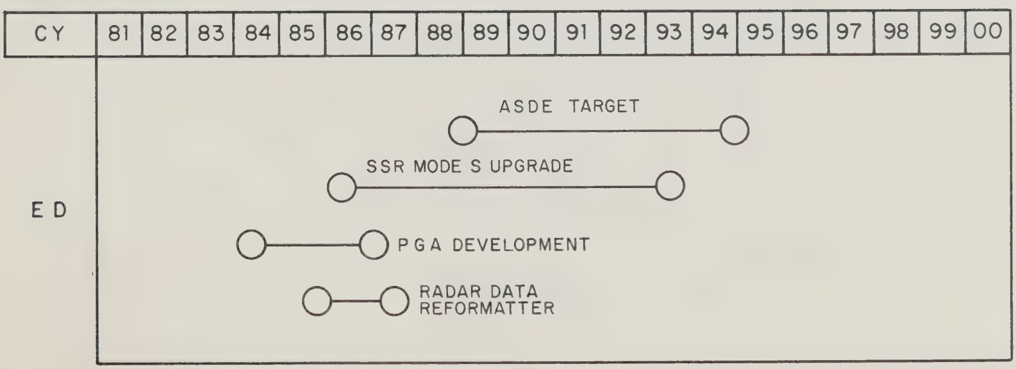
(d) Radar Data Reformatter - Radar data is required by a variety of systems not originally intended to receive the data. A reformatter and general purpose interface system is being developed to allow interconnection to these other systems.

RELATED PROJECTS:

Radar Modernization Project
Airport Surface Navigation Development
Workstation Ergonomics Studies
Automatic Dependent Surveillance Investigations
Aeronautical Information Systems Studies
Development of Radar Support Facilities
Telecommunications Network Investigations
Canadian Aeronautical Digital Network
Advanced Air/Ground Communication and Data Link Studies
Weather Detection, Processing and Dissemination Systems
Radar Data Processing System Enhancements
Tactical Conflict Alerting and Hazardous Airspace Warning
Common Controller Workstation
SSR Mode S Data Link

SURVEILLANCE SYSTEMS ENHANCEMENTS

SCHEDULE



PROJECT: 11. DEVELOPMENT OF RADAR SUPPORT FACILITIES

PURPOSE: Life-cycle management of Air Traffic Control (ATC) surveillance systems requires the prediction and verification of radar coverage extent, quality and accuracy under a variety of environmental conditions. The results obtained determine initial system parameters, including site selection, modifications to the installed systems, or the requirement for changes to ATC procedures necessary to ensure public safety in air travel.

APPROACH: The support will be given through the development of various hardware and software tools and facilities to be added to those presently available. Activities and reports are coordinated nationally and internationally, with other organizations conducting similar efforts. General forecast activities are:

(a) Continued development of coverage prediction (line-of-sight, lobing, etc.) using site specific parameters such as topography, ground cover and buildings;

(b) Investigation and development of test equipment and systems to collect and analyze data both internal and external to the radar system, to evaluate performance under a variety of environmental conditions;

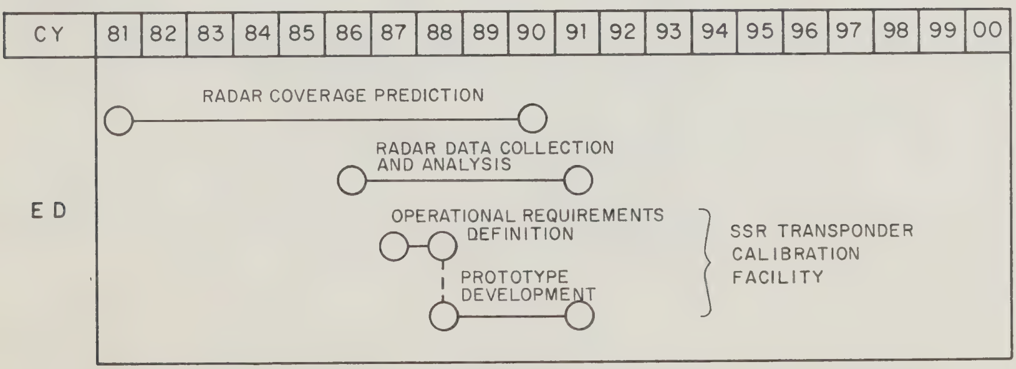
(c) Investigation of the operational requirements, and development of a prototype system to verify the performance of SSR transponders within the tolerances specified in appropriate standards.

RELATED PROJECTS:

Radar Modernization Project
Flight Inspection System Development
Surveillance Systems Enhancements
Artificial Intelligence/Expert Systems Investigations
Microwave Landing System Support Development
Consolidation of Air Navigation System Facilities
Weather Radar
Airport Surface Detection Equipment
SSR Mode S Data Link
Electronics Duty Manager Workstation

DEVELOPMENT OF RADAR SUPPORT FACILITIES

SCHEDULE



PROJECT: 12. WEATHER DETECTION, PROCESSING AND DISSEMINATION SYSTEMS

PURPOSE: The availability of weather information is important to all modes of transportation but it is undoubtedly most critical to aviation. It is required from the time flights are planned, until the aircraft is safely docked after arrival. Weather can be measured through a variety of instruments and it can be predicted with some accuracy. Still, the collection and timely transmission of weather data is labour-intensive and forms a major part of the workload for the flight service specialist or air traffic controller, and data is not readily available from remote areas of the country.

APPROACH: The application of new technologies will be examined to upgrade the detection, processing and dissemination of weather data throughout the Canadian air navigation system:

(a) Automated Weather Observing Systems (AWOS) - Automated sensors will be evaluated for providing standard aviation weather observations at both isolated and manned locations, to increase coverage and reduce workload. The system will automatically transmit data in a digital format over a data network. The feasibility of automatically broadcasting the information using a speech synthesizer will be examined.

(b) Aviation Weather Processing - Weather information will be available from a number of sources, such as the Atmospheric Environment Service (AES) weather system, primary surveillance radars, AWOS, and pilot reports. Investigations will be conducted into the best methods for integrating the data from these sources and for storing, transmitting and displaying it.

(c) Low Level Wind Shear Detection Systems (LLWSDS) - The operational requirements of low level wind shear detection in Canada will be examined. Where confirmation of those requirements is needed, a prototype detection system will be installed for evaluation and the collection of data. Methods for presentation of wind shear information to air traffic controllers will also be investigated. Data collected will be coordinated internationally with other project teams conducting similar studies. If a Canadian requirement is determined, a specification will be developed for the implementation.

(d) Weather Radar Investigations - Weather data is available from AES weather radars and the weather radar channels of the RAMP primary radars. The requirement to supplement this data with Transport Canada dedicated weather radars will be examined.

APPROACH: Cont'd

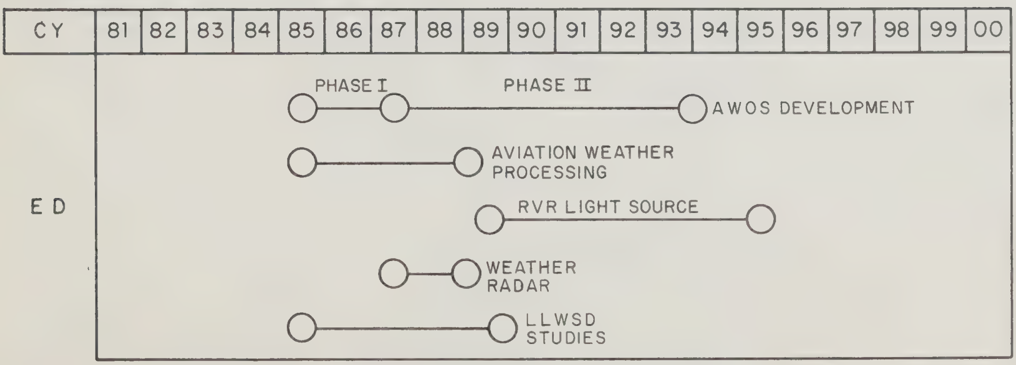
(e) Runway Visual Range (RVR) Light Source Investigations - Alternative, non-incandescent light sources for the new solid-state RVR equipment would improve the reliability and availability of that system. New sources will be evaluated and a specification prepared to retrofit the existing systems.

RELATED PROJECTS:

Flight Information Services Automation
Flight Data Systems Modernization Project
Radar Modernization Project
Aeronautical Information Processing System
Canadian Aeronautical Digital Network
Low Level Vortex Alert System
Consolidation of Air Navigation System Facilities
Telecommunications Network Investigations
Aeronautical Information Systems Studies
Alternative Power Sources
Microwave Landing System
Aviation Weather Processors
Aviation Weather Mass Dissemination
Weather Radar
RVR Systems

WEATHER DETECTION, PROCESSING & DISSEMINATION SYSTEMS

SCHEDULE



PROJECT: 13. LOW LEVEL WAKE VORTEX ALERT INVESTIGATIONS

PURPOSE: Investigations conducted by various organizations in the United States and other countries affirm the presence of turbulence behind flying aircraft. For fixed wing aircraft, the tips of the wings generate circular vortices, in opposite directions to one another, that are most severe immediately following it and that dissipate with time. For rotary wing aircraft, the blade tips generate a turbulence, in addition to the well recognized downdraft, that has shown to be more severe than that of airplanes. The wake vortex has the ability to quickly change the attitude of following aircraft.

To ensure the safety of following aircraft in departure and arrival scenarios, especially when light aircraft follow larger ones, air traffic controllers are obliged to apply minimum time separation standards. This could result in airport congestion, with aircraft delayed either on the ground or in holding patterns. Detecting wake vortices and informing air traffic controllers of their presence would optimize airway and airport capacity and fuel-efficiency.

APPROACH: Investigations will be conducted to determine operational requirements, and the ability of Air Traffic Services to incorporate wake vortex information into operational procedures. Technology investigations and prototype development will follow for evaluation, and to prepare specifications for the procurement and installation of systems where needed. Efforts will be coordinated internationally with other agencies conducting similar studies.

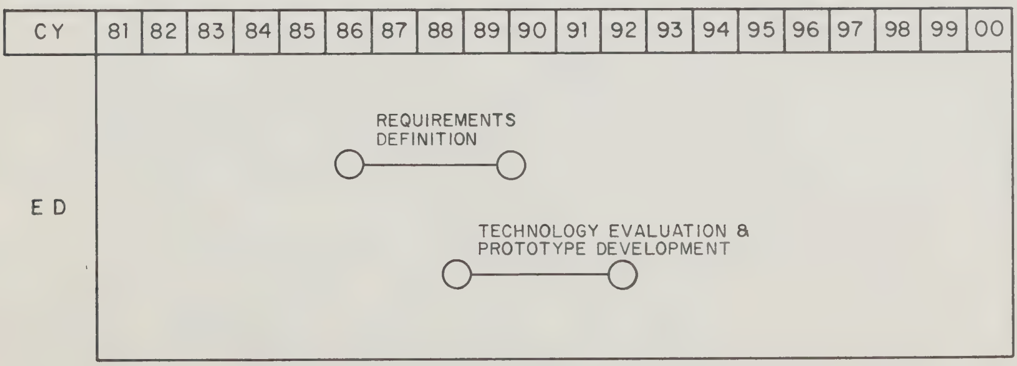
The activities of this project are very closely related to those for wind shear investigations and may become part of the same effort.

RELATED PROJECTS:

Weather Detection, Processing and Dissemination Studies
Workstation Ergonomics Studies
Flight Data Processing Investigations
Surveillance Systems Enhancements
Weather Radar
Microwave Landing System

LOW LEVEL WAKE VORTEX ALERT INVESTIGATIONS

SCHEDULE



PROJECT: 14. FLIGHT DATA PROCESSING INVESTIGATIONS

PURPOSE: The automation and modernization of air traffic services will ensure a high level of safety in the Canadian air navigation system, at a time when demands are being placed on it for greater efficiency and flexibility. Projects such as Flight Data Systems Modernization (FDMP) and Flight Information Services Automation (FISA) will benefit from the extensive capabilities of new computing systems and the availability of more information.

APPROACH: Selected project areas have been identified to prepare for the specification phase of the new flight data processing systems:

(a) Conflict Alerting and Hazardous Airspace Warning - These functions will assist air traffic controllers to identify conflict situations as early as possible, to give pilots ample time to take evasive action. A tactical version, developed under a previous contract, is being incorporated in the Radar Modernization Project (RAMP) system. A strategic version will evolve from algorithms already incorporated in present flight data processing systems, for implementation in the FDMP system.

(b) Conflict Resolution Advisory - This function will provide air traffic controllers with computer-generated alternatives (resolution advisories) when violation of separation minima is about to occur. Operational requirements and procedures will be determined through the development and evaluation of a hardware/software prototype.

(c) Flow Management/Metering and Sequencing - These functions provide the controller with computer models and predictions to support management of airspace. Flow control systems presently developed or under development, airport and airspace capacity models, and the use of weather models, will all be evaluated and modified as required for implementation in future flight data processing systems.

(d) Northern Airspace Systems Design (NASD) - A prototype is being developed to determine the operational and functional requirements of an automated system to replace the manual, prediction and plotting process for air traffic control in the northern regions of Canada. An evaluation of operational procedures, graphic displays and presentation formats will be performed.

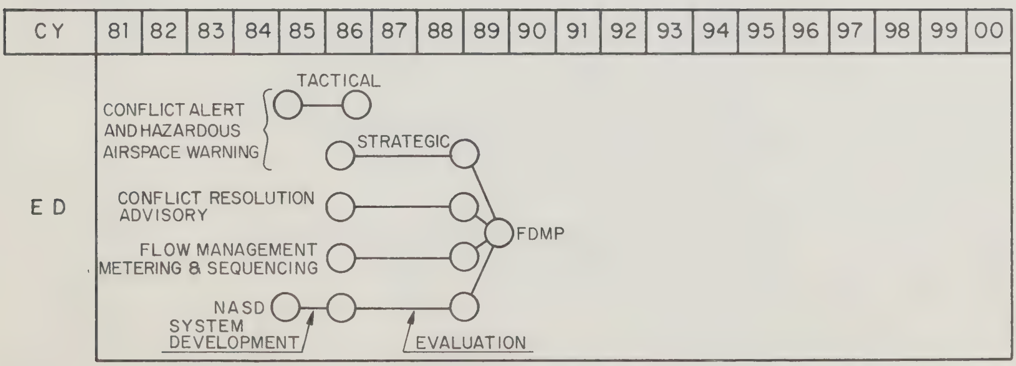
(e) aRea NAVigation (RNAV) - Direct, point-to-point flights allow greater flexibility to pilots in selecting their routes, and benefits such as savings in fuel and reduced flying time. Investigations are necessary to develop new operational and technical procedures to accommodate RNAV in the present structured system.

RELATED PROJECTS:

Radar Modernization Project
Flight Data Systems Modernization Project
Flight Information Services Automation
Workstation Ergonomics Studies
Artificial Intelligence/Expert Systems Investigations
Automatic Dependent Surveillance Investigations
Surveillance Systems Enhancements
Weather Detection, Processing and Dissemination Systems
Low Level Wake Vortex Alert Investigations
Aeronautical Information Systems Studies
Microwave Landing System
Advanced Air/Ground Communication and Data Link Studies
Gander Automated Air Traffic System
National Flight Data Processing System Enhancements
Aeronautical Information Processing System

FLIGHT DATA PROCESSING INVESTIGATIONS

SCHEDULE



PROJECT: 15. AERONAUTICAL INFORMATION SYSTEMS STUDIES

PURPOSE: The provision of accurate and timely aeronautical information is essential to ensure safe and efficient control and service to the aviation community. Information such as weather conditions, reserved airspace, and the availability of airway and airport facilities is collected from a myriad of sources such as the NOtice to AirMen (NOTAM) systems, the PIlot REPorts (PIREPS), via air traffic controllers and flight service specialists and the Atmospheric Environment Service weather network. The distribution of this information is through various Air Traffic Services (ATS) facilities.

At present, the collection and distribution of this aeronautical information is labour-intensive and subject to a number of different operational procedures. The new automated systems will require most or all of this information in their operation, and future plans will see it consolidated in one of these systems. A study of both the operational requirements and the present information systems will determine the eventual collection and dissemination system for this data.

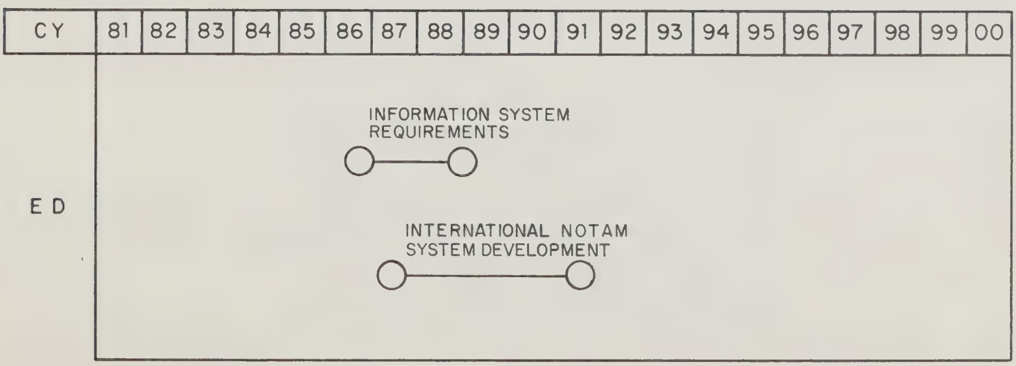
APPROACH: The verification and review of the operational requirements of present information systems and procedures will be performed and the results analyzed with the requirements and capabilities of the new systems being installed. Included will be a new automated NOTAM system to process international NOTAM's, in keeping with international commitments. A review of this total information distribution will provide an overview for the Advanced Integrated ATC System. Specifications will be prepared to meet requirements.

RELATED PROJECTS:

Workstation Ergonomics Studies
Flight Data Processing Investigations
Weather Detection, Processing and Dissemination Systems
Advanced Air/Ground Communication and Data Link Studies
Speech Processing and Transmission Systems Development
Surveillance Systems Enhancements
Telecommunications Network Investigations
Flight Data Systems Modernization Project
Flight Information Services Automation
Aeronautical Information Processing System
Canadian Aeronautical Digital Network
NOTAM System Automation

AERONAUTICAL INFORMATION SYSTEMS STUDIES

SCHEDULE



PROJECT: 16. WORKSTATION ERGONOMICS STUDIES

PURPOSE: New, highly automated workstations have been proposed to extend the efficiencies of systems developed under the Flight Data Systems Modernization Project, the Flight Information Services Automation, and the Control & Performance Monitoring System (CPMS). Evaluation is required of the interface points between the system and the operator/user, based on human factors and device capabilities and placement.

APPROACH: Studies are performed using a number of different input/-output technologies such as those presently underway with touch interactive display devices, the uses of colour in air traffic displays, and the replacement of stroke driven displays by high-resolution, raster-scan displays. Prototype or mock-up workstations will be developed to determine data format requirements and to test the utility and placement of the input/output devices required to perform the operational tasks. Information is exchanged nationally and internationally, with other project offices conducting similar efforts. Results of the evaluation will be used in developing specifications for the procurement of future systems. Specific project areas presently identified are:

(a) Common Controller Workstation Development for air traffic control;

(b) Flight Service Specialist Workstation Development for flight service stations;

(c) CPMS Workstation Development for system maintenance technicians;

(d) Direct User Access Terminals (DUAT) to provide aircraft operators and pilots with direct accessibility to pre-flight information and flight plan filing;

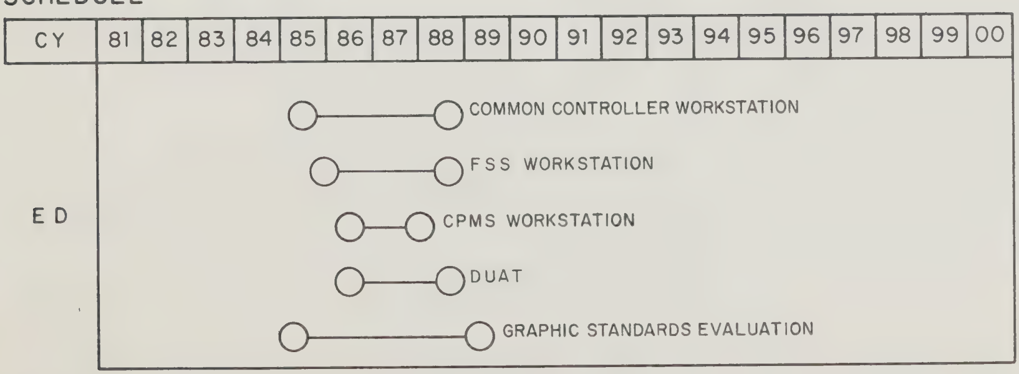
(e) Evaluation of Graphics Standards to meet operational and technical requirements.

RELATED PROJECTS:

Flight Data Systems Modernization Project
Flight Information Services Automation
Control and Performance Monitoring System
Computer-Based Training Studies
Artificial Intelligence/Expert Systems Investigations
Speech Processing and Transmission Systems Development
Aeronautical Information Systems Studies
Microwave Landing System
Electronics Duty Manager Workstation

WORKSTATION ERGONOMICS STUDIES

SCHEDULE



PROJECT: 17. CONSOLIDATION OF AIR NAVIGATION SYSTEM FACILITIES

PURPOSE: Each site at which a communication, navigation or surveillance facility is located, has an associated overhead, such as land purchase or rental, servicing, interfacility communications and maintenance. The collocation and consolidation of these facilities would minimize the costs associated with that overhead, if technical limitations or system incompatiblities are eliminated. New installations in particular would realize the greatest cost savings.

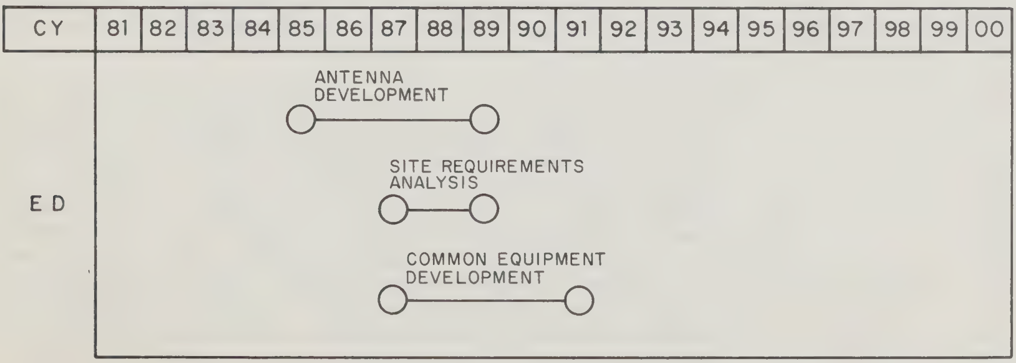
APPROACH: The equipments and systems supporting the Canadian air navigation system will be evaluated for compatibility and cost reductions possible with consolidation. Prototypes of common equipment such as amplifiers and antennas will be developed and evaluated. Siting requirements peculiar to each different system will be examined for trade-offs. Recommmendations will be made on possible alternatives, and specfications will be prepared for national implementation of the required enhancements.

RELATED PROJECTS:

Canadian Aeronautical Digital Network
Telecommunications Network Investigations
Remote Maintenance and Monitoring Development
Alternative Power Sources
Development of Radar Support Facilities
Weather Detection, Processing and Dissemination Systems
Advanced Air/Ground Communication and Data Link Studies
Consolidation of Comm., Nav. and Surveillance Facilities
Control and Performance Monitoring System

CONSOLIDATION OF AIR NAVIGATION SYSTEM FACILITIES

SCHEDULE



PROJECT: 18. FLIGHT INSPECTION SYSTEMS DEVELOPMENT

PURPOSE: A new, all-weather flight inspection system has been developed and installed on Transport Canada's regional aircraft calibration fleet, to increase the efficiency of flight inspection and to improve the quality of measurements. It is comprised of the Digital Flight Inspection System (DFIS) and the Self-Contained Aircraft Position Equipment (SCAPE). The present system accommodates Very High Frequency Omni Range (VOR) and Instrument Landing System (ILS) flight inspections only, and it is necessary to extend its capabilities to satisfy other requirements.

APPROACH: A number of areas have been identified where the new flight inspection facilities are needed. Each of these areas will be examined to verify the requirements and determine the technical alternatives. Enhancements will be developed to the existing DFIS/SCAPE systems. The foreseen project areas include:

(a) Microwave Landing System (MLS) - To accommodate the arrival of MLS the DFIS/SCAPE will be extended to include flight calibration capability for MLS on the same basis that ILS is presently accommodated.

(b) Air/Ground Communications - Methods to evaluate the design tailored service volumes of communications facilities will be developed. This will assist in the management of frequency assignment and permit better utilization of the frequency spectrum. It will enable coverage validation and investigation of reported air/-ground communications problems.

(c) Surveillance Systems - Methods to verify radar coverage and reporting accuracy will be developed. The information contained in SCAPE will be transmitted to the radar site to correlate the information displayed.

(d) ElectroMagnetic Compatibility (EMC) - Electromagnetic interference near radio facilities, affecting the facility operation, has been of concern for many years. A system to evaluate the effect high voltage power distribution systems have on our communications, navigation and surveillance systems, will assist in developing adequate protection criteria.

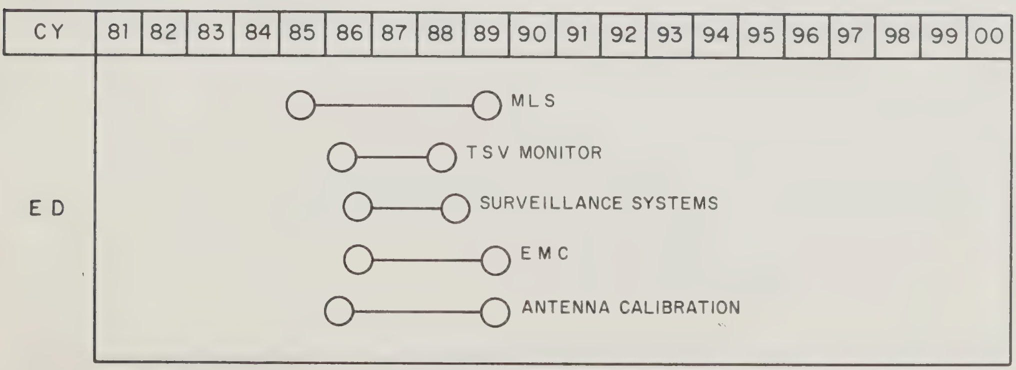
(e) Aircraft Antenna Calibration - Although DFIS/SCAPE are self-contained, calibrated systems, the DFIS is connected to antennas mounted on the aircraft's skin through cables, connectors and combiners. As the location of the antennas on the aircraft, the type of antenna used and the altitude of the aircraft all have a bearing on the signal received, average correction factors are used to account for the losses in this part of the system. Methods will be developed for absolute calibration of these antennas. Methods will be developed for absolute calibration of these antennas.

RELATED PROJECTS:

- Radar Modernization Project
- Microwave Landing Systems
- Air/Ground HF Communications
- VOR/DME/TACAN
- Non-Directional Beacons
- VHF/DF
- VLF/Navigation Transmitter Evaluations
- Surveillance System Enhancements
- Advanced Air/Ground Communication and Data Link Studies
- Consolidation of Air Navigation System Facilities
- The Flight Inspection Fleet Plan

FLIGHT INSPECTION SYSTEMS DEVELOPMENT

SCHEDULE



PROJECT: 19. REMOTE MAINTENANCE AND MONITORING DEVELOPMENT

PURPOSE: To reduce the maintenance costs associated with the life-cycle responsibility of electronic systems, and to increase their availability, the specifications for major new systems include a remote maintenance and monitoring (RMM) capability. It will alert maintenance personnel when a fault occurs and allow them to identify which component or module has to be replaced. Eventually all systems, including existing equipment, will be required to support RMM and they will be linked to central maintenance facilities through the Control and Performance Monitoring System (CPMS).

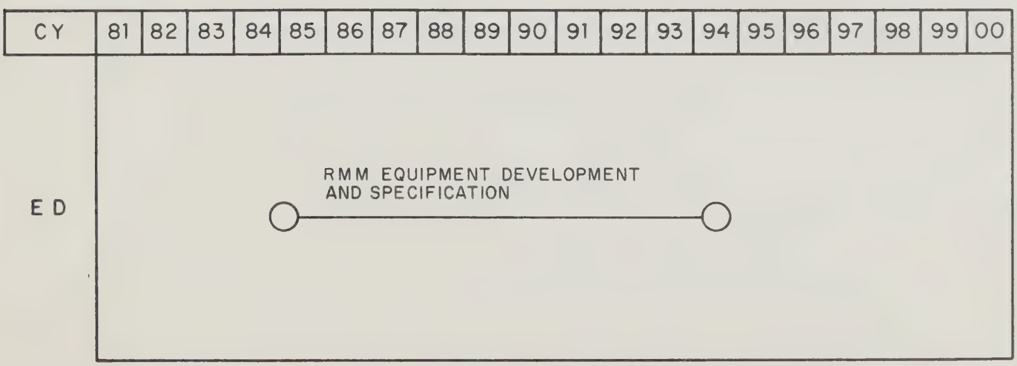
APPROACH: To provide existing systems, such as radio facilities and navigation aids with a RMM capability, the characteristics and configurations particular to each equipment will be analyzed. Prototype RMM devices, to provide the interface between the systems and CPMS, will be developed and evaluated. These devices could also include stand-alone diagnostic capability for on-site analysis. The results obtained from this development phase will be used in preparing specifications to retrofit the existing facilities.

RELATED PROJECTS:

Control and Performance Monitoring System
Consolidation of Air Navigation System Facilities
Alternative Power Sources
Canadian Aeronautical Digital Network
Telecommunications Network Investigations
Electronics Duty Manager Workstation

REMOTE MAINTENANCE AND MONITORING DEVELOPMENT

SCHEDULE



PROJECT: 20. ALTERNATIVE POWER SOURCES

PURPOSE: The selection of sites for weather collection, communication and navigation aid equipment is determined to a large extent by the availability of power; they are often located near power lines by necessity, even though other sites are more operationally suitable. Future operational requirements will necessitate some equipment to be installed at remote sites. These sites will have stand-alone, reliable power sources that require only infrequent inspections or refurbishments.

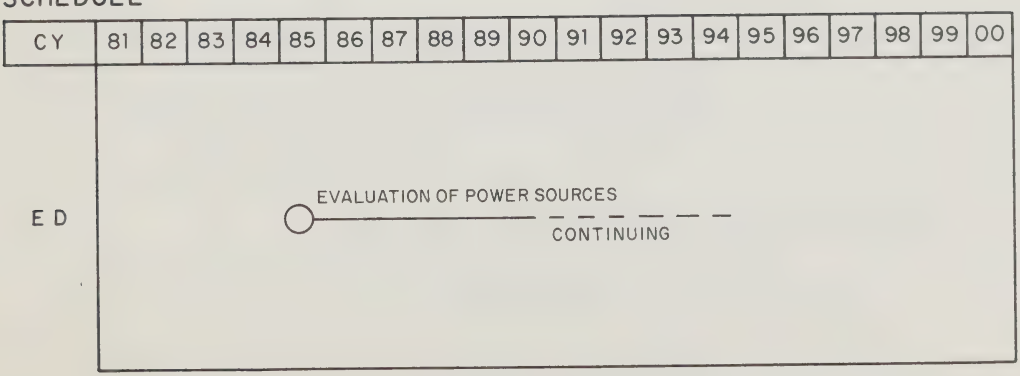
APPROACH: Continuing studies will evaluate the capability of proven technologies to supply the power requirements of various equipment configurations. Solar panels, wind turbines and other technologies will be monitored for their limitations and capabilities, including life-cycle costs, ruggedness and power capabilities. Where operational requirements indicate the necessity for such a power source, a prototype will be evaluated in suitable environmental conditions. The result will be used in the preparation of a specification for additional procurements.

RELATED PROJECTS:

Flight Information Services Automation
VOR/DME/TACAN
Non-Directional Beacons
Weather Detection, Processing and Dissemination Systems
Consolidation of Air Navigation System Facilities
Telecommunications Network Investigations
Remote Maintenance and Monitoring Development
Control and Performance Monitoring System

ALTERNATIVE POWER SOURCES

SCHEDULE



PROJECT: 21. AIRPORT SECURITY SYSTEMS DEVELOPMENT

PURPOSE: Government legislation requires the provision of security systems to protect passengers, crew and aircraft at airports. Existing systems are being extended or replaced where deficiencies exist, and new systems will be installed to provide the required, totally secure environment. Some of the enhancements and new security systems proposed necessitate a development phase to meet the requirements particular to the Canadian situation and an increased threat situation worldwide.

APPROACH: An ongoing review of existing systems is being performed, with the participation of various federal security agencies. Present systems will be enhanced and some new systems will be developed to meet requirements identified. New technology will be examined and applied wherever it can improve reliability and provide a greater level of security. Prototypes will be developed and evaluated, and specifications prepared for systems to be installed nationally. The following are some of the main development efforts:

(a) Pattern Recognition X-Ray Devices - A system using an x-ray sensing device and incorporating expert system technology is under development to recognize weapons or other dangerous objects in carry-on luggage, and alert operators of their presence;

(b) Explosives Vapour Detectors - Enhancements are being investigated for present detectors, and new faster responding detectors are being developed for possible installation on aircraft and at baggage handling and passenger screening areas;

(c) Automated Passsenger Screening Point - An information system and database will be developed to correlate baggage with boarded passengers, specifically identifying particular baggage items without a corresponding owner on-board, and its location on the aircraft.

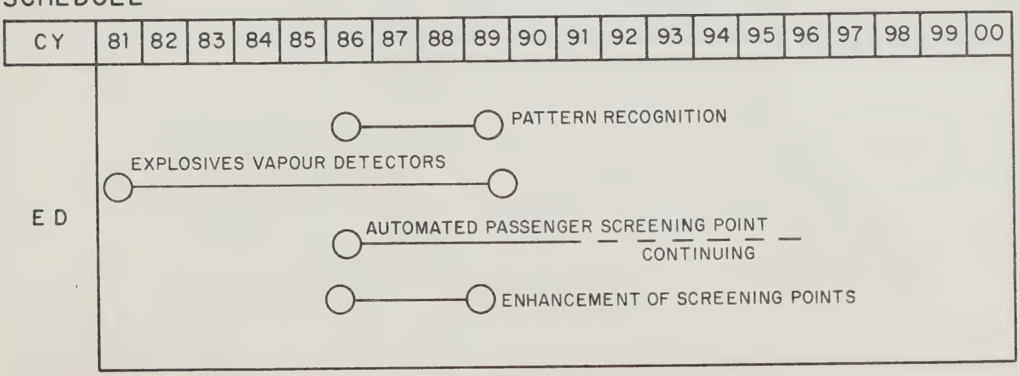
(d) Screening Point Enhancements - Present x-ray devices are being enhanced and sensors are being developed for remote monitoring of walkthrough units to improve screening and safety and to increase the effectiveness of personnel.

RELATED PROJECTS:

Artificial Intelligence/Expert Systems Investigations
Airport Security Systems

AIRPORT SECURITY SYSTEMS DEVELOPMENT

SCHEDULE



PROJECT: 22. ARTIFICIAL INTELLIGENCE/EXPERT SYSTEMS INVESTIGATIONS

PURPOSE: Artificial Intelligence/Expert Systems are an emerging technology that will become state-of-the-art in the mid 1990's. Expert Systems will improve productivity by assisting personnel in performing their duties, doing mundane tasks, and providing an 'expert' level advisory service when required. They also have the capability to provide a type of computer-based training.

Artifical Intelligence/Expert Systems will be offered by contractors in proposals to new future systems, when they provide an efficient and effective way to meet the requirements specified. Investigations are required to develop a strategy to evaluate those proposals. The technology can only be accepted with assurance that public safety is not jeopardized and life-cycle costs are not unduly increased.

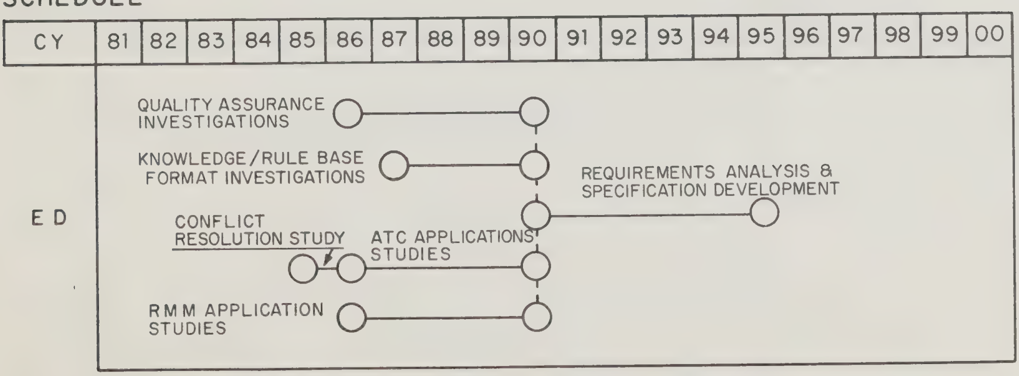
APPROACH: Investigations will be made of format structures for knowledge and rule-based systems, standards for system quality and integrity, and potential application areas, where maximum benefits would be realized. Studies will be conducted in cooperation with other agencies, nationally and internationally, to ensure maximum advantages can be obtained in standardization and to minimize duplication of effort. Guidelines will be prepared to enable project managers to evaluate proposals containing Artificial Intelligence/Expert System features.

RELATED PROJECTS:

Flight Data Systems Modernization Project
Flight Information Services Automation
Control and Performance Monitoring System
Aeronautical Information Processing System
Workstation Ergonomics Studies
Flight Data Processing Investigations
Weather Detection, Processing and Dissemination Systems
Airport Surface Navigation Development
Speech Processing and Transmission Systems Development
Airport Security Systems Development
Computer-Based Training Studies

ARTIFICIAL INTELLIGENCE / EXPERT SYSTEMS INVESTIGATIONS

SCHEDULE



PROJECT: 23. COMPUTER-BASED TRAINING STUDIES

PURPOSE: The new equipments identified for the Canadian air navigation system, and updated procedures in operations and maintenance, will require highly qualified personnel to ensure the efficiency and effectiveness of the overall system. Initial training provides personnel with the necessary knowledge and skills to perform their duties, and refresher training helps maintain and upgrade them. The application of computers to this discipline could provide more cost-effective alternatives to traditional methods, particularly for refresher training. New workstations could incorporate training features, with a minor cost increase. Computer-based training systems in operations and maintenance centres would provide:

- reduced costs compared with travel to central training facilities;
- flexibiility in student self-pacing and course scheduling;
- national standardization of course material; and
- rapid dissemination of course updates for refresher training.

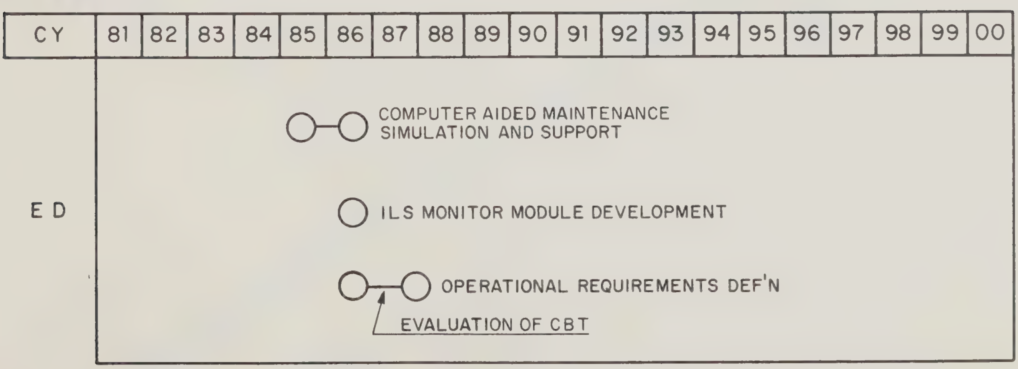
APPROACH: Studies will be conducted into the equipment and technologies available to support computer-based training for the operation and maintenance of the Canadian air navigation system. Evaluations will be performed of the relative cost and training benefits of traditional and computer-based training. For the latter, comparisons will be made between embedded and integrated systems to determine the merits of each. Both initial and refresher training will be considered. Prototype computer-based training modules will be developed to determine their effectiveness. Recommendations will be made to provide policy direction.

RELATED PROJECTS:

Control and Performance Monitoring System
Workstation Ergonomics Studies
Artificial Intelligence/Expert Systems Investigations

COMPUTER BASED TRAINING STUDIES

SCHEDULE



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